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Construction Features of Granville Dam for City of Westfield, Mass.

How a $630,000 Earth Dam Project Is Being Handled

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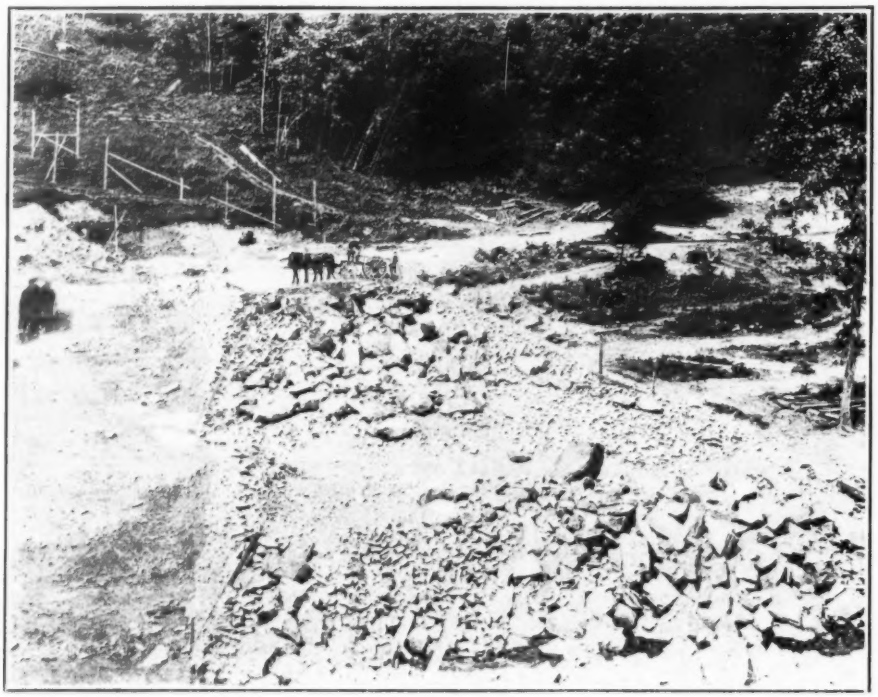
THE construction of this project, now under way, involves a total expenditure, exclusive of the purchase of land, of $630,000. The work comprises the building of an earth dam and appurtenant structures, the preparation of the reservoir site for the storage of water, and the building of a short supply main. Most of the work is being done under contract.

Bids for the work were received Sept. 12, and the contract was awarded to the low bidder Oct. 28, 1927. Fifteen contractors submitted bids, ranging from $430,000 to $880,000; the lowest bid was 26 per cent below the average of all bids.

Construction work began in the late fall of 1927 and continued to February, 1928. Only a very small amount of work was done during this period; namely, the construction of a contractors' camp, the laying of about 600 lin. ft. of 20-in. pipe, and the erection of a cableway. Work began in earnest in April, 1928, and was carried on as fast as practicable until the first of December, 1928, when all operations were stopped on account of weather. During this period, work costing $350,000 was completed. The indications are that the project will be completed well within the specified time of Oct. 31, 1929.

Order of Operations.—The order of operations decided upon at the beginning of the work required the completion of all concrete work and a small amount of the embankment during 1928. Although it was necessary to do much more rock excavation and concrete work than was originally planned, due to the character of the foundation material, all of the concrete work was practically completed and also about one-quarter of the embankment.

Work was first started, at the dam, on the outlet conduit. The construction of the cut-off wall, the preparation of the dam site for the embankment and the construction of the upper gate house then followed and this work was carried on simultaneously. During the latter part of the season, the excavation of the road on the south bank of the dam, the construction of the spillway and spillway channel and the lower gate house was nearly completed; the borrow pit was opened and the earth embankment completed to an average height of 16 ft.; a considerable amount of



The Stone Toe

work was done in preparing the reservoir site for the storage of water; and the 20-in. supply main was completed.

Outlet Conduit.—The outlet conduit consists of a reinforced concrete pipe 42 in. in diameter, and a 24-in. cast iron pipe embedded in concrete, about 740 ft. long, built in a rock trench varying in depth from 3 ft. (outside the dam) to 25 ft., and averaging about 15 ft. The flow of the brooks is diverted into the conduit through a special inlet structure. It is discharged into the old brook channel a considerable distance below the dam. The conduit passes through the upper gate house, where gates will control the flow of water in it.

The construction required especial attention, as it was necessary to establish the profile as the trench excavation progressed. The rock encountered for the entire length of the conduit was granitish gneiss, traversed by many seams in a very irregular manner, and in many places badly disintegrated. This not only made the excavation much more costly to the contractor, as a large amount of rock was excavated without blasting, but it was necessary to remove much more rock and use much more concrete than originally anticipated. Only light charges for blasting were permitted by the specifications, and this specification was strictly enforced. The depth of all holes only average 2.6 ft. and the amount of dynamite used was kept to a minimum.

The conduit was built in sections averaging 40 ft. in length. Concrete was first poured to the spring lines of the 42-in. The second pour was to a height of 9 in. above the crown. The cast iron pipe was then laid and the concrete poured around it.

Wooden forms were used for the 42-in. conduit. They were built semi-circular, in sections 10 ft. long, of 2-in. by 8-in. ribs spaced 2 ft. on centers, lagged with ⅞-in. by 1⅞-in. stock.

Concrete collars were built about every 30 ft. at the bottom and sides of the trench and to the top of the banks of the trench, to prevent any seepage along the conduit.

A 400-ft. cableway was used for removing the excavated material, handling the cast iron pipe and other material over that part of the trench where the excavation was the deepest. A Byers crane was used for this purpose on the remainder of the trench. Most of the concrete was poured from portable mixers located along the bank.

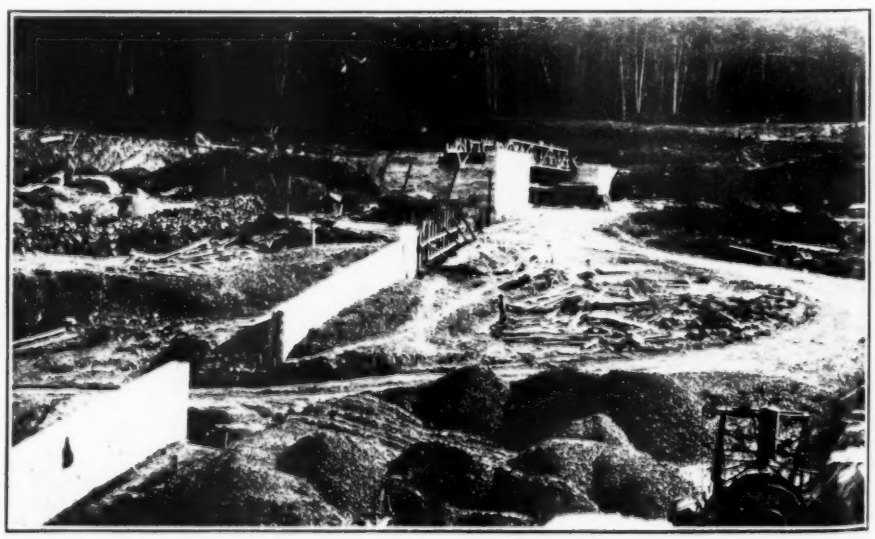
This structure was completed in four months at an average cost of $67 per linear foot.

Cut-Off Wall.—It was thought, previous to construction, that only a simple cut-off wall would be required. The contract drawings called for a concrete wall to be built across the floor of the valley in as narrow a trench as possible, resting on bed rock and extending above the surface of the ground about 5 ft. As bed rock is very deep on the banks of the valley, it was planned to use timber sheet piling together with a simple wall there, or an earth cut-off. Timber piling could not be driven and it was decided to build the cut-off of concrete for the entire length of the dam.

Excavation for cut-off wall was first started on the south side of the floor of the valley. As soon as bed rock was encountered, it was tested for water-tightness. One-inch holes 10 ft. deep took water at the rate of about 5 gal. per minute under a 20-ft. head at the bottom of the hole. This fact, together with knowledge obtained regarding the character of the rock from the outlet conduit excavation, caused a change in the design of the wall.

The material overlying bed rock, across the floor of the valley, is silt, sand, gravel and large boulders and is very compact; on the north bank there is a layer of hardpan overlying soft, reddish, fairly uniform sand; on the south bank, the material is silt, grey granitish sand and fine gravel; and at the southerly end of the dam, there is a considerable amount of rock flour silt.

The trench across the floor of the valley was opened to an average width of 8 ft. at the bottom and 20 ft. at the top, but on the banks of the valley, the trench was kept to a minimum width of about 3 ft. A seal coat of concrete was poured over the bed rock and the bed rock was grouted. The wall across the floor of the valley was built on the downstream side of the trench. It was built in sections 40 ft. long and that



Cut-Off Wall on South Bank of Valley

part below ground surface was built in steps. Walls were built across the trench at the end of each section, enabling the puddle backfill, which consisted of rock flour silt and topsoil, to be placed in sections. The wall across the valley was built to an average height of 10 ft. above the ground. Particular care was taken in grouting the foundation and building the wall at its intersection with the outlet conduit. On the banks of the valley, the depth of the trench varied from 12 ft. at the foot of the bank to 9 ft. at the top and the height of the wall above the ground surface varied from 10 ft. at the foot of the bank to 5 ft. at the top. Passageways were left in the wall for use later in hauling the material to the dam for the embankment.

Grouting Bed Rock.—The entire length of bed rock was grouted. A set of 1-in. drill steel was used which gave a diameter of hole at the top of about 3 in. The holes were spaced 15 ft. center to center in two lines about 7½ ft. apart and the locations of the holes were staggered. A total of 60 holes were drilled, 52 of which accepted grout. At the beginning of the operation, the grout was mixed in the proportion of 1 part cement and 7 parts water. As the hole tightened, the mix was increased to 1 part cement and 3 parts water. The grout was first applied under a pressure of 15 lb. and gradually increased to 80 lb. The minimum amount of cement used per hole was ½ bag, the maximum 75 bags and the average 10¼ bags. A very small amount of grout was lost. The total cost of grouting was $2,475 or about $4.25 per linear foot of hole.

At the present time, the cut-off wall is practically completed. Four months were required to build the wall and the average cost per linear foot was $92.

Upper Gate House.—The upper gate house is a reinforced concrete structure 22 ft. by 30 ft. and approximately 85 ft. high with a 1-story brick superstructure. It consists of a drywell and a wetwell. The wetwell does not extend to the very bottom of the structure, there being a large section of mass concrete about 28 ft. high underneath it. The reinforced walls for a height of 28 ft. above the foundation are 4 ft. thick; and above this they are 3 ft. thick.

Lower End of Spillway Channel

This structure was built on a rock foundation of the same character of rock as was encountered in the outlet conduit trench. It was necessary to excavate more rock and to place more concrete than was originally estimated. The concrete in this building was placed in pours as large as practical, averaging about 100 cu. yd. per pour. The concrete for the lower part of the structure was poured by gravity from a mixer located on the south bank; that in the middle part of the structure was handled from the mixer by a crane. A steam hoist elevator was used to handle the concrete above this elevation. The forms consisted of 2-in. by 6-in. spruce planed on one side with 3-in. by 4-in. studs 2 ft. 0 in. center to center and 4-in. by 6-in. ribbons 3 ft. 0 in. center to center. The forms were double wired 3 ft. 0 in. center to center both ways.

The progress of the work depended upon the construction of the forms and as only a limited number of men were able to work on the forms at one time, the construction of the building progressed slowly.

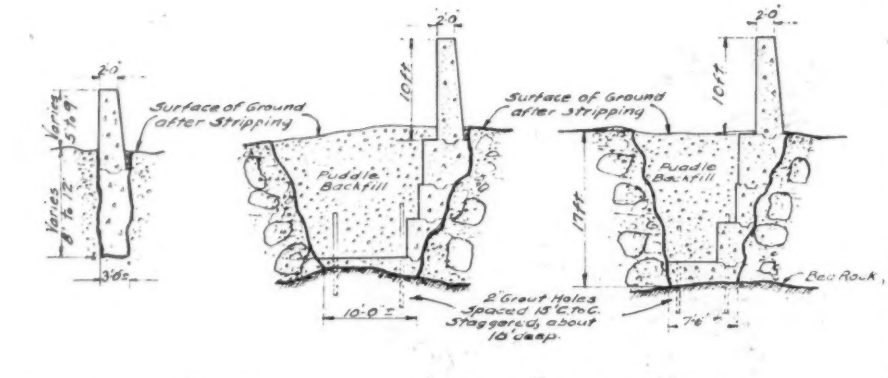
The total cost of this structure will average about 95 ct. per cubic feet of gross volume.

Rolling Earth Embankment

Main Dam.—The dam is an earth embankment built by the layer fill method, with a stone toe and heel, and stone facing on the upstream slope. 240,000 cu. yd. of earth, 30,000 cu. yd. of stone, 8,000 cu. yd. of gravel and 2,000 cu. yd. of soil dressing will be used. The stone embankments and facing have been laid out to utilize all of the stone excavated for appurtenant structures and all stone encountered in the borrow pit. The average cost per cubic yard of the entire embankment will be about 85 ct.

Preparation of the Site.—The first work in the construction of the main dam was the preparation of the site for the embankment. This work included the removal from the site of all stumps, topsoil, loose boulders, and material which in its natural state was quite permeable.

A large part of this work was done by a steam shovel. The final operation



Typical Cross Section of Cut-Off Wall

of cleaning up the loose material left by the shovel was done by hand labor. This work progressed slowly at first due to the difficulty of hauling the material away. The Linn tractor was of particular value, having no difficulty in hauling a full load over rough ground on a grade of 20 per cent.

Many boulders were encountered in the stripping of the site. It was necessary on account of these boulders to do a large amount of the work by hand labor. All loose boulders were removed for use in building the stone toe of the dam.

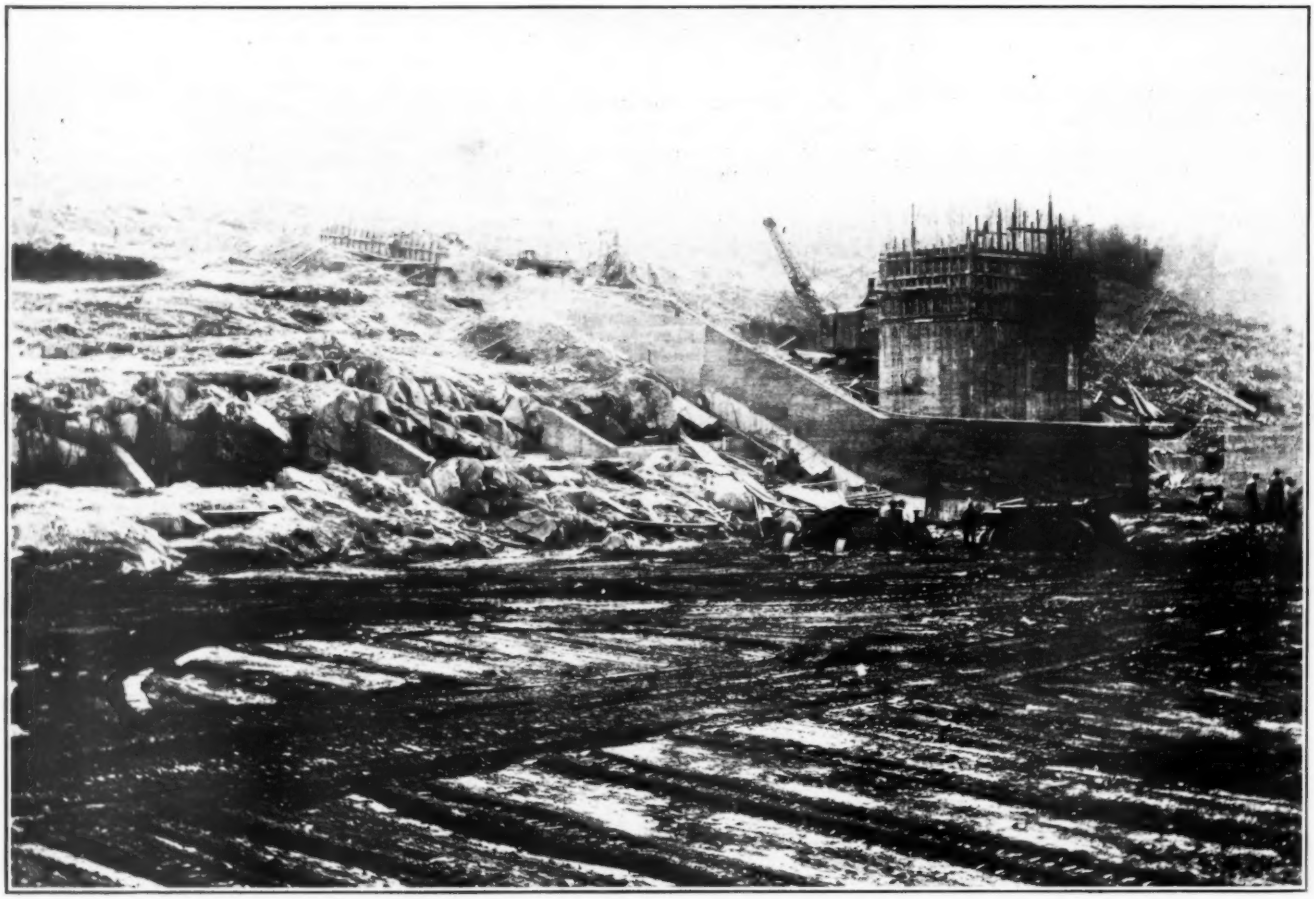
Work at the Borrow Pit.—While the work in preparing the dam site was under way, a road was excavated to the borrow pit and a part of the pit was grubbed and stripped.

The pit is located on the north bank of the valley about ¼ mile from the center of the dam. It is on a side hill with an average cross slope of about 3 to 1.

Investigations conducted previous to construction and since proved to be correct, showed that this side hill was covered by a layer of hardpan approximately 10 to 15 ft. thick at its junction with the floor of the valley and 60 to 80 ft. deep at the top of the hill. Underlying the hardpan, there is a large volume of uniform reddish, micaceous sand which is very permeable, and therefore unsuitable for the earth embankment.

The contract permitted the contractor to open the borrow pit in any location he deemed desirable on the side hill, but not nearer than about 300 ft. from the embankment. He elected to open the pit at about elevation 550, about 10 ft. above the top of the dam, where the depth of the overlying hardpan would be great enough to permit the economical excavation and handling of the material. The road from the pit to the floor of the valley at the dam site is on an average grade of 10 per cent. As the height of the embankment increases, the alignment of the road will be changed somewhat, thus decreasing the grade of the road.

The excavation in the pit is being carried to the entire depth of the good material. It is being made by two Byers steam shovels, equipped with ¾-yd. buckets. These shovels are capable of excavating the bank to a height of about 25 ft. It was first planned to terrace the cuts with depths not greater than could be made by the shovels in one cut, but this idea has been abandoned due to the difficulty of handling the hauling equipment in the pit. When the height of the bank reaches about 25 ft., a cast over cut is made from the

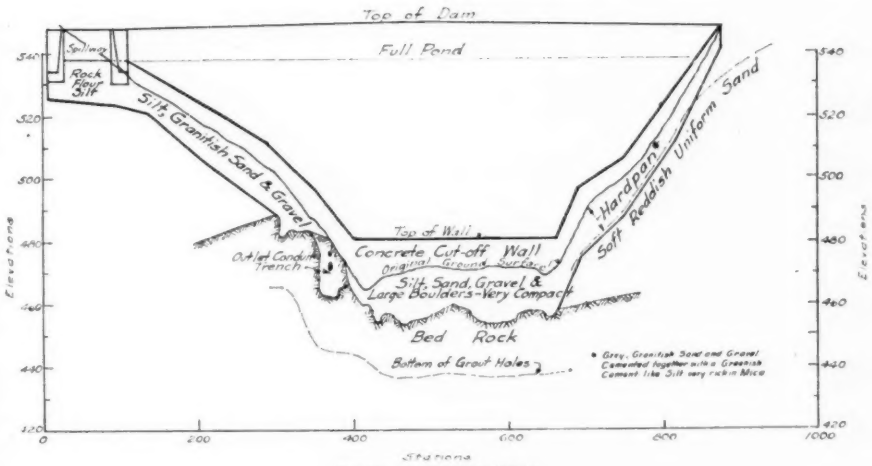


Cut-Off Wall at Intersection with Outlet Conduit

top of the bank by a Byers gasoline shovel equipped with a 1-yd. bucket. This shovel casts the material over the bank, where it is rehandled by the steam shovels before another cut into the bank is made. It is not necessary to use the gasoline shovel on this work all of the time.

The hardpan is very difficult to excavate. The teeth of the buckets are made of manganese steel, but it is necessary to change them frequently. The excavation of this hardpan could be done more economically by larger and more powerful shovels, but, however, the size of the shovels being used fits in very well with the general scheme of handling the material. They are quite speedy and are capable of excavating the material as fast as it can be properly handled at the embankment. If larger shovels were used, additional spreading, rolling and hauling equipment would be required.

Hauling of Material from the Borrow Pit to the Embankment.—At the beginning of the work, the contractor was undecided on the type of equipment to use for hauling the material from the pit to the dam. Numerous types were considered; namely, belt conveyors and trucks, auto trucks, Linn tractors, and tractor trains. The contractor purchased a 7-ton Linn tractor for general use on the job, and as soon as the earth embankment was started, this machine started hauling from the pit.



Profile of Cut-Off Wall

A 60-hp. Caterpillar tractor, manufactured by the Caterpillar Tractor Co., and two bottom dump steel wagons, manufactured by the LaPlant-Choate Manufacturing Co., were purchased on trial. Three-ton Mack trucks equipped with dual-pneumatic tires on the rear wheels were hired. Time studies were made to determine the comparative cost of hauling the material by the machines. These studies were made at the beginning of the work when hauling conditions at the embankment were poor and at a time when the pit was not large enough to permit the easy handling of the equipment there. As a result of this study, additional tractors and wagons were ordered at once. As the hauling conditions at the embankment and in the borrow pit improved, it was found that the Caterpillar tractors could haul three wagons and the Linn tractor could haul in addition to its usual load, one wagon, and therefore, additional wagons were ordered. At the end of the season, the material was being hauled by three tractor trains of three wagons and by the Linn tractor and one wagon. It is expected that the remainder of the filling material will be hauled by this equipment only.

Work on the Embankment. — The work at the embankment consists of

Work at Borrow Pit

spreading and rolling of the material; the sorting from the earth of roots over ½ in. in diameter and stones over 6 in. in the greatest dimension. A 60 hp. Caterpillar tractor equipped with a LaPlant-Choate bulldozer is used for spreading the material. A 7-ton Buffalo-Springfield roller is used to assist the other equipment in compacting. A 1½-ton truck, a foreman and five men are used to sort the roots and stones, direct the dumping of the earth and the placing of the stone and gravel.

Amount of Compacting.—Perhaps the most essential factor to consider in building earth embankments is the compactness of the mass, as the greater the compactness the greater the weight, and in most cases the greater the imperviousness.

The specifications for this job require "the filling material shall be distributed in approximately horizontal layers not exceeding 6 in. in thickness when compacted. . . . The compacting shall be done by approved rollers having grooved or banded rolls and operated by mechanical power except that in small embankments and around the structures other means approved by the engineer may be used. The heaviest wheels of the roller shall cause an average pressure of at least 250 lb. per linear inch width of roll. The roller shall pass over every portion of each layer as many times as may be necessary, but not less than six times in any case."

This specification conforms closely with the specification commonly used for the building of layer filled embankments. The specification commonly used does not include an allowance for compacting done by equipment other than that used for rolling alone. Before motorized equipment became so common in use, the compacting of embankments was done by horse drawn rollers and by the trampling of stock. In the early dams, the material was hauled to the embankment in most cases by horses and wagons, and later by industrial trains. At the present time, with the heavy motorized equipment available, such as we are using in Westfield, consideration must be given to the amount of compacting which it does. It is true that this type of compacting is not entirely uniform, but it can be quite carefully controlled.

The engineers on this project were very much pleased when the contractor decided to use tractors and the large wagons. Surely the compacting resulting from a 10-ton tractor working on the embankment is very beneficial.

The distance travelled and the area covered on the embankment during a 9-hour day, while building a layer 5½ in. thick after being compacted, together with the wheel loads of all equipment have been determined. With these data and knowing the area of the embankment, the average number of trips made on the embankment per layer is computed for each machine. The product of the average number of trips and the average wheel load per linear inch width of tread gives the relative amount of compacting.

The relative amount of compacting given for the tractor treads should possibly be reduced to conform more closely with the amount of compacting given for wheel loads, due to the additional concentration of a wheel load. However, considering wheel loads only, the amount of compacting done by the wagons alone exceeds the minimum requirement of the specifications.

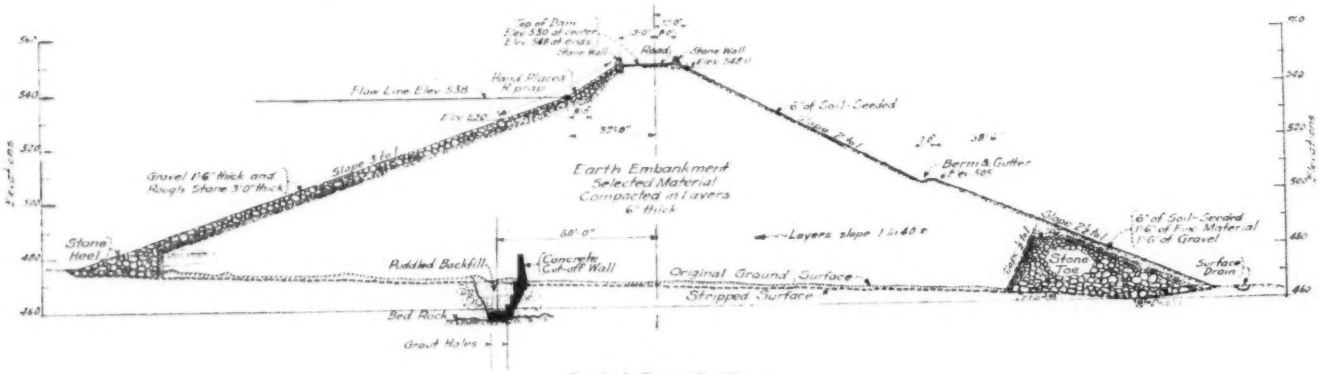
Specifications for layer filled embankments should be written to conform with the equipment to be used and the specifications should be complete and include an allowance for the compacting done by the hauling equipment. On this particular job, much more compacting is being done than was specified, but if the contractor had decided to haul the material to the dam by industrial trains or by other means, which would not give the amount of compacting equal to that represented in the tabulation, additional rolling equipment would have been required.

Numerous test pits have been dug in the embankment. Below a depth of 1 ft., it is impossible for a laborer to dig the material without the use of a pick. Laborers say that it is as difficult to dig as any natural material they have ever dug. Unfortunately, we have not at the present time, any figures which we can safely rely upon to give the amount of shrinkage of this material. At the end of this work, we will have quite definite figures for this factor.

Soil Tests.—The various kinds of soil encountered are tested in the field office by a simple method worked out by Dr. Charles Terzaghi of the Massachusetts Institute of Technology. The method involves the use of a device for measuring the capillary rise of water in soil.

Last season, 425 samples of material were tested in our field office. Of this number, 264 were of material being used in the dam embankment. The average coefficient of permeability of the 264 samples is .00007 cm. per second and the volume of voids 34 per cent. The line of saturation and the amount of leakage expected were computed on the basis of the coefficient of permeability averaging .0001 cm. per second. The material is some better than originally anticipated.

A system of pipe drains has been built underneath the stone toe, the main drain of which passes through a catchbasin just below the dam. Ditches which will collect the surface drainage on the face of the dam will discharge into this catchbasin. A weir has been built in the catchbasin so that the amount of leakage through the dam can be measured. Weirs have also been built on each brook at the head of the reservoir. During the construction period, daily records are kept of the flow of water over these weirs and also the flow of water in the brooks after they join at the mouth of the outlet conduit. If records are kept of the amount of water used from the reservoir after construction and the amount of water entering the reservoir, together with the heights of the reservoir, and the amount wasted, the approximate amount of leakage through the walls of the reservoir may be determined. Such a figure will be of particular value to check the estimates made of the leakage by the geologists.



Typical Cross Section

Miscellaneous Structures.—The lower gate house, a small structure 16 ft. by 20 ft., consisting of a concrete basement and brick superstructure, houses gates which will control the flow of water in the supply main. Provisions have been made in the layout of the piping so that the water may be returned to the brook or to an aeration plant, which may possibly be needed.

The supply main extends from the lower gate house along the brook a distance of ½ mile to a connection with an existing main. It is a 20-in. c. i. pipe laid in a trench with an average depth of 7½ ft., located on a steep side hill. The total cost of this pipe line per linear foot was about $11.50.

The spillway and spillway channel were built on the steep south bank of the valley. At the upper end, a large amount of rock flour silt was encountered and the sides of the spillway are gravity retaining walls. Sand, gravel and rock were encountered most of the distance and the slopes of the channel are paved. Rock was encountered at the lower end of the spillway where the alignment is on a curve. The channel was built in sections 30 ft. long and on chords around the curves. Movable forms were used for the slope paving. At the lower end of the channel, difficulty was had in hauling the excavated material from and hauling the construction material to the channel, as the grade here is 18 per cent. The only hauling vehicle which could operate on this grade was the Linn tractor.

A road has been excavated from an existing road to the south end of the bridge. This road will cross the spillway and the dam. A pony truss bridge with a concrete deck has been built across the spillway. The steel for the bridge was fabricated in Worcester and the trusses, 60 ft. in length, were transported via highways to the site. Only a small amount of trouble was had navigating the truck and trailer around the sharp curves approaching the job.

A considerable amount of material excavated from the road and spillway channel was not suitable for use in the embankment. This material was used for blanketing swampy places in the reservoir. In connection with the preparation of the reservoir site for the storage of water, some work has also been done stripping the flow line. Most of the material on the banks of the reservoir is sand and gravel. A Byers gasoline shovel has been used in making a single cast over cut along the flow line. This results in thorough stripping for a depth below the flow line of about 10 ft. and blanketing a similar depth below the cut. This scheme of treating the flow line eliminates a great amount of hauling of the stripping material and leaves the shores of the reservoir in a much better appearance.

General.—The contractor, the C. & R. Construction Co. of Boston, has cooperated fully at all times with the engineers on this project. The job has been exceptionally well equipped at all stages of the work. The total cost of all equipment used amounts to $124,000.

Previous to beginning the construction work which has been described, the city did a considerable amount of work in preparing for a reservoir in this location. 300,000 pine trees were planted on the watershed as a part of the reforestation work so well done in this city. Nearly all of the land in the watershed has been acquired, and all possible sources of pollution have been eliminated.

Acknowledgment.—The foregoing is an abstract of a paper presented Feb. 13 before the New England Water Works Association.

Treatment of Paper Mill Wastes

The recently issued 1928 report of Abel Wolman, Chief Engineer Bureau of Sanitary Engineering, Maryland State Department of Health, contains the following:

The investigation at the paper mill of the Congoleum-Nairn, Inc., which has been in progress for several years, was continued. Experiments were conducted on the waste treatment plant, which was placed in operation in 1927, to determine whether some other coagulant than alum might be used. During the course of the experiments, ferric chloride alone, ferric chloride plus lime, alum alone and alum plus sulphuric acid were used. The results obtained with ferric chloride were not sufficiently better than with alum to justify a change. A treatment of 90 grains per gal. of lime and 50 grains per gal. of alum produced an effluent approximately equal to that obtained with alum at the rate of 140 to 180 grains per gal. Further work along this line will be done to reduce the amount of waste still reaching the stream.

In the operation of the coagulating basins a new procedure has been used. The basins were so designed as to make it impossible to draw off all of the supernatant liquid from the tank, the outlets being 2 ft. from the bottom of each basin. Formerly, this entire 2-ft. depth was discharged to the lagoon. It is now taken from each tank to one coagulating basin where it is re-treated and re-settled. The supernatant from this tank is discharged to the stream and the resulting sludge discharged to the lagoon. The supernatant liquid from the lagoon is run off to a cinder bed and thence to a second cinder bed from which it passes to the stream. These cinder beds are 4 by 6 ft. in area and contain 5 in. of cinders and 5 in. of sand. The cinders and sand are removed and replaced with new material about every fourth day. Treatment of the cinder bed effluent with lime would produce an excellent floc and a practically water white supernatant, but this treatment has not been required since the amount of discharged waste has been very small.

Court Decision on Construction of Sewer System

Public Health Reports for Feb. 15, gives the following court decision handed down Nov. 23, 1928, by the Kentucky Court of Appeals in the case of Baker v. City of Princeton (11 S. W. (2d) 94):

Chapter 88, Laws of 1928, authorized the construction, maintenance, etc., of sewers in fourth-class cities. After this statute went into effect, the city of Princeton, a fourth-class city, passed an ordinance providing for the construction of a sewerage system.

About 20 years before, the city had constructed a small sewer system in the business section, which system served a few residences, including two belonging to the plaintiff. A fee of $20 was paid to the city for the privilege of connecting with the system, and there was no further charge.

The plaintiff instituted an action to enjoin the city from proceeding with the letting of contracts and the construction of the sewer system under the above-mentioned law and ordinance. It was insisted that the plaintiff and others who had paid the fee of $20 had acquired a vested right which the city could not interfere with or take away. The court of appeals did not take this view of the matter, saying that "The mere right to tap a sewer system in consideration of a specified fee is simply a temporary privilege which must yield when it becomes necessary to discontinue the old system, and construct a new system in order to promote the public health."

One of the other points made was that the city council was without power to create a single district but should have created several districts so that the burden would fall more equally on the property owners. Concerning this the court said that "There is nothing in the act that requires a city council to divide the city into separate districts. On the contrary, the whole matter is left to the sound discretion of the board of council (cases cited), and the courts are without authority to interfere, even though they may believe it would be more advisable to adopt a different plan."

The court concluded its opinion by saying that "the city has the power to construct the proposed sewer system in accordance with the terms and conditions contained in the ordinance."

City-County Consolidation in California

The San Francisco Bureau of Governmental Research in a recent report recommends the consolidation of the city and county of San Francisco with San Mateo County into one unit as a "city-county with adequate provisions for local representation on a central legislative body, a centralized administration of common governmental functions, and the retention of local powers and control of local functions by local units, or boroughs." The proposal has a double purpose, as do most of the proposals for metropolitan government, namely: (1) to provide adequate services for a growing metropolitan district in the way of highways, regional planning, water supply, sewage disposal, port facilities, transportation, schools; (2) to eliminate duplication of functions in, and reform faults of existing units of government. The proposed new unit would include a population of 745,000 and an area of 489 square miles.

Weighing the Probable Truth of a Theory

By HALBERT P. GILLETTE, Editor

THERE is a prevalent belief that men equally informed as to the facts are equally competent to weigh the merits of a scientific theory; but the history of science shows that a very large percentage—usually a great majority—of scientists have not been competent to appraise a new theory.

Newton's theory of gravitation was not generally accepted in Europe until long after his death. Prout's theory of the genesis of atoms from hydrogen was rejected by all authorities for nearly a century. Einstein's theory of relativity was practically ignored by scientists for 15 years after its publication. Each of these three theories was supported by quantitative evidence that should have carried conviction the instant the theory and the evidence were grasped. These three are typical of scores of quantitative theories that have had to wait decades, or even generations, before general acceptance was secured.

After making allowances for mental inertia, skepticism, egotism and all the psychological conditions that prevent an impartial and thorough study of a new theory, a good deal of mystery remains as to the slowness with which a true theory receives general approval. It will not do to attribute such slowness to commendable scientific caution, especially where the evidence was overwhelming when the theory was first announced. We must look for other reasons.

In searching for other reasons I have come upon one that seems to explain most of this phenomenon of skepticism about new theories. It is the prevalent failure to test new theories by the laws of probability. Treatises on logic usually discuss such tests in the most perfunctory manner, if they discuss them at all. Treatises on probability are often but little better, for their authors usually seem to have scant appreciation of the power of the science of probabilities in testing theories, to say nothing of its usefulness in discovering natural laws.

Of the 90 known atoms (out of the 92 that are supposed to exist) about one-quarter have atomic weights that are integral numbers. When, in 1815, Prout announced his theory that hydrogen atoms are the "bricks" of which the other atoms are built, the percentage of the then known atoms that possessed weights that were integral multiples of that of hydrogen exceeded 25 per cent. Let us assume, however, that 10 atoms in 40 exactly corresponded with Prout's theory. What was the probability of its truth? If any atom selected at random had an atomic weight that was an integral multiple of that of hydrogen, the probability that it would have such a weight merely by chance would be excessively small. But let us assume that it would be 1 in 2; or that it either would or would not have an integral weight. Then if 10 random selections from the 40 resulted in finding 10 atoms having integral weights, the probability of this happening purely by chance would be only 1 in 2 to the 10th power, or 1 in 1,004. Since there were 40 atoms, the fact that only 10 of the 40 had integral weights, would reduce the probability to 1 in 251. Even 251 to 1 in favor of a theory is overwhelming evidence; but remember that in this case we have assumed an initial probability of 1 in 2, which is far too small a ratio. All the possible weights that an atom might have other than an integral multiple of hydrogen, are so nearly infinite that we have no means of estimating them. When, therefore, we say that the chance is even that an atomic weight will be an integral multiple of hydrogen, we are grossly over-estimating that chance. Indeed so gross is our over-estimate that we are safe in saying that if even 2 atoms out of 90 have weights that are integral multiples of one another, they are almost certainly related as causes of one another, or a concomitant resultants of a common cause.

But the chemists looked only at the instances where Prout's theory seemed to fail, and never weighed the significance of the instances where it held true; so they rejected the theory for a century. Recently it has been found that where atoms have fractional weights, they are mixtures of isotropes that have integral weights. Thus chlorine has an atomic weight of 35.46 as a result of the mixture of three isotropes of chlorine whose weights are 35, 37 and 39. So the very exceptions that were cited against Prout now are seen to prove his rule.

Were this an isolated instance of the misjudging of a scientific theory by all the authorities save its originator, it should at least serve as a warning to skeptics. But it is not isolated. On the contrary, scientific history swarms with similar instances. Of course the initial evidence in favor of many a new theory is relatively weak, but actually the degree of its weakness is rarely demonstrated by an appeal to the law of probabilities. Instead, the critics merely guess that it is weak; and usually their guesses are influenced by its apparent failure to agree with some known fact or facts, rather than by its proved agreement with several known facts.

When any theory is in close quantitative accordance with even a very few facts, it is rare that it fails to show a very high degree of probability if tested by the laws of probability.

One celebrated astronomer, commenting on the slowness with which Newton's law of gravitation was accepted, says that this slowness was not surprising because Newton had not shown its accordance with very many astronomical facts. This statement is clear evidence of this astronomer's ignorance of the use of the laws of probability in testing such a theory; for, had Newton only proved that his law held true of the earth and the moon, still that proof would be very convincing to anyone familiar with the elementary principles of probabilities. But Newton's law fitted Kepler's laws so perfectly that he had thus extended it to include all the known planets; and he had also carried it far enough to explain quantitatively the height of the ocean tides. Truly it is astounding to find any astronomer hesitating to accept such proof as conclusive.

If it be argued that Newton wrote when science was in its infancy, the answer is Einstein's experience. Einstein offered in proof of his relativity theory that, by its aid, he had deduced two laws previously deduced by Lorentz, who in his deduction, had used the well established principles of electrodynamics. That alone was proof overwhelming that Einstein's relativity theory must be sound. But Einstein added one of the most spectacular tests of a theory that has ever been published. He deduced, by his theory, the 43 secs. of arc per century through which Mercury's orbital axis rotates, in excess of the rotation accounted for by Newton's laws; and his deduction agreed with the fact within the observational error. Yet this marvelous proof of his theory caused scarcely a ripple of interest in a scientific world which, 25 years later, is all agog over Einstein's latest development of the same theory. It is true that one of Einstein's original predictions was found to be correct 10 years ago, and that this awakened the attention of the scientific world. But this itself shows a surprising ignorance of what constitutes a crucial test of a theory. To predict a future occurrence accurately is certainly spectacular, but it is not a whit more difficult than to deduce from a theory a quantitative result in accordance with any known fact that was not used in deriving the theory. Einstein's deduction of Mercury's known orbital change was just as conclusive evidence of the truth of his theory as was his deduction of the amount by which a ray of light bends when it passes near the sun. That thousands of modern scientists failed to appreciate that this is so, is one of the most conclusive proofs that few of them know how to weigh evidence scientifically.

There is great need, therefore, of study of the principles of probability, and particularly of their application to measuring the worth of new theories. In a later article I will indicate the use of the science of probability in discovering natural laws.

Westchester County Planning and Park System

Some Interesting Facts on a Notable Park Development

ONE of the most notable park systems in this country is that of Westchester County, New York. An interesting account of the development and success of this work was given by Jay Downer, chief engineer of the County Park Commission in a paper presented at the 1929 annual meeting of the American Society of Civil Engineers. The following digest of Mr. Downer's paper is taken from the March Proceedings of the Society.

Outstanding Accomplishment.—"Westchester County, New York, during the past five years has made a contribution to park history, regional planning, and practical execution hitherto unmatched by any other municipality in the world in an equal period of time. Three outstanding features may be offered in support of this rather broad claim: First, the comprehensiveness of the County Park System which includes water-front and interior recreational areas and reservations, and an extensive system of interconnected traffic parkways; second, the speed of execution in the acquisition of lands, development, and construction work; and, finally, the self-supporting financial basis attained through the creation of property values and the development of revenues from special park privileges and facilities."

The County and Its Problem.—Lying just north of New York City, the County has 448 sq. miles stretching between the Hudson River and Long Island Sound. It embraces forty-five subordinate municipalities, including four cities, and boasts a total population of 500,000. Coincident with New York City's northward growth, development in Westchester County has been startling, being especially accelerated during recent years, and now along its Southern border being almost a continuation of New York City. Being of ancient origin, the various towns are connected with an extensive network of highways, many of them dating from the Colonial period—a typical rural road system. It was with such a problem that the County Park Commission had to cope.

"Scenic attractiveness," said Mr. Downer, "accessibility to New York City, and the trend of present growth strongly indicate Westchester County's future destiny as the most attractive residential area of the New York Metropolitan District. Industrial development in this area is very limited and, aside from control through zoning ordinances, the physical characteristics of hill and valley topography make Westchester less attractive for industrial invasion than the flat expanses of Jersey meadows threaded by water and rail transportation facilities.

"Broadly stated, the planning problem presented by Westchester County is that of a large satelloid area directly in the only mainland path of growth of New York City and destined to be devoted to residential purposes as its major utilization, but with local distribution and retail business districts to supply the needs of a greatly increased future population. Among the leading essentials for the planning of this area are the requirement of maintaining and enhancing the natural endowment of attractiveness for residential uses and the necessity for providing open traffic ways for the large volume of through-motor traffic between New York City and Upper New York State and New England which must necessarily pass through Westchester County."

County Park System.—By combining county parks for arterial traffic parkways, the Commission has been enabled to form the main elements of a general plan which is expected to mould the future development of the County very largely. Naturally, the general plan had to be accommodated to existing development and thus compromises from the ideal had to be effected. Certain well-defined fundamentals dictated this development, according to Mr. Downer. Among these he included the following:

"Elemental Features: Water-front parks along the Hudson River and Long Island Sound shores, and interior parks, reservations, and forest preserves providing for a wide range of recreational uses. An interconnecting system of traffic parkways.

"Economic Utilization of Land: Selection of the cheapest undeveloped lands, such as marshes, stream, and pond margins, or rocky uplands, undesirable and difficult to develop for residential or business uses, but ideal for park purposes and as such allocated to their most valuable economic utilization in the general scheme of county development.

"Adaptation to Physical Characteristics of Region: The diversified irregular and somewhat bold topography precluded conventional geometric planning. Such planning could not be rationally or economically adjusted to the physical conditions.

"Adjustment to Existing City, Town, and Village Developments: Interwoven with the foregoing was the necessity for effecting the most feasible compromises with existing conditions of the unplanned suburban growth.

"Rapidity of Execution: One of the most important elements was prompt action in acquiring lands in advance of rapidly rising values, leaving the shortest possible gap between planning and the execution of this phase of the program."

Parkways.—After showing the general layout of these parks and parkways, Mr. Downer continued:

"The north and south parkways, traversing the stream valleys in the direction of greatest traffic flow, serve the multiple purposes of open recreational areas, motor traffic routes of least resistance, the natural drainage routes of trunk sewers, and possible future locations of water supply conduits and other public utilities. The parkway reservations which include controlling strips of land on both sides of the streams also forestall the development of nuisance conditions such as developed along the Bronx River Parkway and led to its construction principally as a sanitary improvement project prior to the general county park program. The parkway system is coordinated with the older existing county highways."

The first of these parkways, Mr. Downer explained, called the Bronx River Parkway, was a joint undertaking between Westchester County and the City of New York. It extends 12 miles through the county and 3 miles within the city. About three years before this work was finished, the County adopted its expanded park program, working under a park commission of six members serving without compensation. One year was devoted to study, after which definite recommendations were made, all of which were adopted by the County Board of Supervisors and the requisite appropriations unanimously voted.

Extent of Park Development.—As a result of five years' active work, said Mr. Downer,

"The Commission has established a regional park system embracing within the limits of Westchester County, 16,671 acres of land, 140 miles of parkway routes, and 9 miles of beaches and shore lines along the Hudson River and Long Island Sound. This work has involved the acquisition of about 3,500 separate parcels of land, a large proportion of which was acquired by direct purchase from owners, thus avoiding the delays incidental to tedious condemnation proceedings.

"Coincidentally with the acquisition of land, a construction and development program has carried to completion seven new large-scale recreational developments, including bathing beaches, bath houses, concrete swimming pools,

a wide range of athletic, recreation, and picnicking grounds, three public golf courses, forest preserve areas, and a seaside amusement park embodying a unique and unusual feature under municipal operation. Under this development program 17 miles of fully developed traffic parkways have been completed giving a total of 29 miles, including the Bronx River Parkway."

Basic Practice in Parkway Design.—What Mr. Downer styled the "Westchester County type of parkway" is being recognized as the most economic solution. By establishing attractive residential zones along the roadways, valuations are greatly enhanced; this is largely in contrast with the depression of land values along trunk highways flanked by billboards. The Westchester practice is to utilize the minimum width of 200 ft., enlarging this where cheap land is available or where water-surface development is feasible. Mr. Downer continued:

"As to the motor driveways, the standard practice is to lay pavements 40 ft. wide for four lines of traffic. Grade separations have been effected at all main intersecting thoroughfares which are carried over or under the parkway drive by bridges. The rigid-frame type of stone-faced reinforced concrete bridge has been applied to the grade-separation problems with very satisfactory results both as to economy of construction and pleasing architectural adaptations. On the Bronx River Parkway the type of pavement was a concrete base with 2½-in. bituminous wearing surface, but the newer projects are standardized on reinforced concrete pavement, with asphaltic emulsion applied to eliminate glare. Grading and bridge openings are being carried through to a width of 60 ft., as the necessity for increasing the initial 40-ft. pavement width to 60 ft. in the not distant future is foreseen.

"Economics.—The park program is financed as to capital investment in lands and permanent improvements, through the standard type of county bonds running for 45 to 50 years and usually underwritten at an interest rate of 4 per cent. The yearly operation and maintenance charges are carried as an item of the general county budget raised by current tax revenue.

"From 1922 to the end of 1928, the total capital appropriations were as follows:

Acquisition of lands	$32,297,000
Improvement and construction	18,515,900
Total	$50,812,900

"Although not susceptible of exact calculation, it may reasonably be held that the creation of enhanced property valuations has fully offset the capital appropriations, regardless of the public welfare benefits of the park system. The sharp upward trend in assessed valuations immedately after the establishment of the park system is shown by the following figures:

Year	Total Assessed Valuation of Taxable Property	Increase
1921	$ 676,103,963	
1922	733,007,069	$ 56,903,106
1923	788,029,096	55,022,027
1924	891,331,983	103,302,887
1925	987,068,857	95,736,874
1926	1,143,871,106	156,802,249
1927	1,318,826,453	174,955,347
1928	1,501,531,153	182,704,700

"The influence of the park program is apparent in the increased valuations in 1924 and subsequent years. From 1924, when this influence became evident, up to and including 1928, the total increase in assessed valuations was $710,797,357. At the previous rate of increase the total for the same 5-year period would have been about $300,000,000. An increase of about $410,000,000, or about eight times the total amount of the appropriations, is, therefore, reasonably attributable to the park program."

Self-Support.—One of the outstanding results, remarked Mr. Downer, has been the attainment of a "self-supporing maintenance basis," by virtue of rentals, concessions, etc., for the use of the recreational and amusement features of the park system. He then quoted the following statistics to "show the rapid trend of earnings toward completely balancing the operation and maintenance budget:

Year	Park Operation and Maintenance Budget	Income from Park System	Net Cost of Operation
1922	$ 25,000.00	$ 272.50	$ 24,724.50
1923	54,000.00	126.00	53,874.00
1924	258,309.33	46,191.98	212,116.35
1925	529,529.99	60,944.40	468,585.99
1926	733,103.33	313,102.75	420,000.58
1927	750,125.28	462,518.98	287,606.30
1928	1,202,958.93	1,142,803.36	60,155.57

"Although 29 miles of modern parkways and an extensive system of recreational projects were in operation in 1928, the net cost of the county was only $60,155. The parkways yield no direct income, but are of incalculable value in the saving of time and in convenience and safety for the traveling public.

"An Early Success.—Although the importance of a regional park system as an item of major importance in planning for the future growth of Westchester was clearly foreseen, considerable courage was required to launch it as the largest scale improvement program ever undertaken by the county. But officials and leading citizens had full confidence that the ultimate results would amply justify the enterprise. The results which are shown by the foregoing balance sheet, frankly, have been attained in a much shorter period of time than originally was anticipated.

"The demonstration afforded by Westchester that the idealism of a well-conceived planning program may rest on a sound economic basis is providing stimulus to many other municipalities both in this country and abroad."

Parkway vs. Trunk Highways.—As any one familiar with the Westchester work would readily realize, the parkways are one of the fundamental factors. Perhaps this work is as widely and favorably known for this one feature as for any other. Certainly, these parkways seem to be one of the basic ideas or backbones of the entire work. Mr. Downer explained the underlying purpose of this part of the work, as follows:

"We are building parkways in Westchester instead of great, new trunk highways. This has been a fact which has been stressed at city planning conferences during the last two years by some of our eminent, far-thinking city planners, which is now getting into the public consciousness; the fact that we do not want to spend all our money on wide state roads, that we cannot afford to build too many super-highways, which are simply wide slabs of concrete without protection of frontages. There has been a good deal in the papers about that during the last few years, and if you knew as I do how many people are now coming to our office to study that feature—the distinction between a parkway and a broad state highway—you would realize that that is something to reckon with.

"In other words, the people are beginning to demand protection of frontages on these expensive improvements, not only that the improvement itself may be enjoyable instead of a disfigured thoroughfare, disfigured by cheap stands and billboards and tawdry business development, but that the improvement may eventually pay for itself in its influence upon the zone which it serves.

* * * * *

"New Locations Cheapest.—Another thing we have found in Westchester is that it seldoms pays to lay out a great traffic route by widening an existing road. I am speaking now, of course, of suburban areas where you have a great deal of vacant land, only sparsely developed, which could be utilized for new routes. We found in Westchester after starting out many times to widen highways, that we could always, or in most cases, get 200 or 300 ft. in back somewhere cheaper than we could get 20 or 30 ft. to widen an old highway where the frontages were improved, and where you would pay for damages in cutting off fronts of fences, front gates, dooryards, etc.

"So we went in behind, where land was donated; a great deal sold at prices below the market in order to entice the improvement. We have there not only a wide parkway instead of an 80-ft. road, but we have controlled frontages, we have a great deal of restriction on the adjoining property, and we have controlled, to a very large extent, access drives and crossings so that these can be developed as fast trafficways with the greatest margin of safety."

Pouring Asphalt Joints in Brick Pavements With a Pressure Distributor

Method Used on Recent Paving Jobs at Flint, Mich.

By H. C. McCLURE
City Engineer, Flint, Mich.

A BRICK paving job recently completed in Flint has several interesting features. The job, known as the North Saginaw St. improvement, called for a pavement 74 ft. wide between curbs. The street was paved an entire new brick surface for a portion of the distance, and with new 27-ft. strips outside of the street railway track space, for the balance. In all, paving totaled around 60,000 yd.

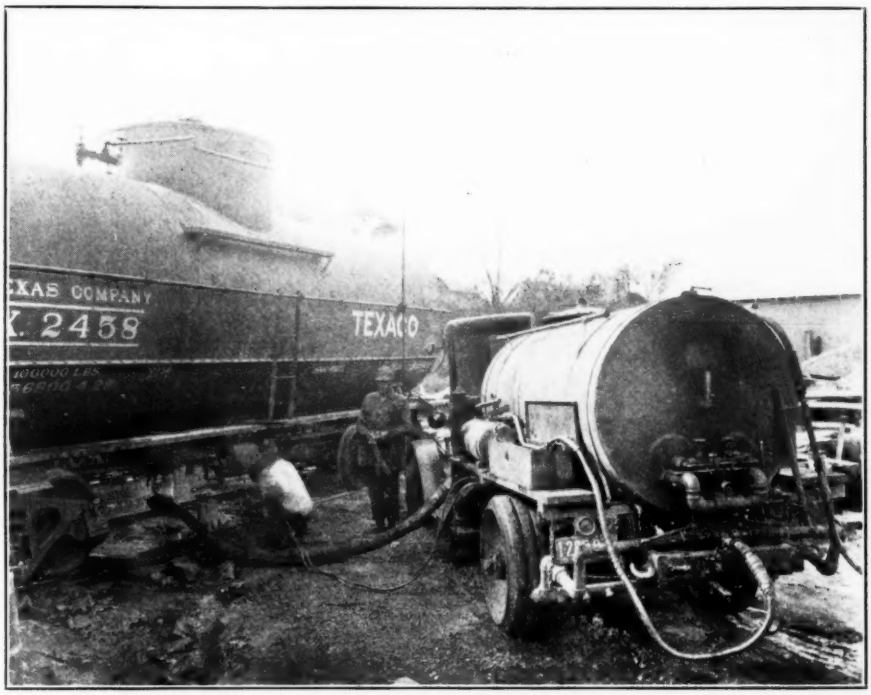
The specifications called for an asphalt joint filler to comply with state highway specifications for this product, the contractor finally decided on "Texaco 39" for the work

Because of the location of this job, it was deemed advisable to eliminate as much interference on the street as possible, and to reduce complaints and nuisances on the street. The suggestion was made to the contractor that he secure his asphalt in insulated tank cars, ship them directly to the engineering department siding where plant steam would be available, and then use a distributor tank truck for applying this filler. This suggestion was adopted and worked with more than the expected degree of success.

Handling Asphalt from Tank Car to Street.—The asphalt reached the plant siding at a temperature of 175° or above, and required only about four hours of plant steaming to make pumping into the distributor possible. A distributor truck, manufactured by the Hendricks Co. of Morenci, Mich., was employed for this work. This distributor carried a jacketed pump, operated from a power take-off, which not only fills the tank but circulates or discharges the asphalt, as well, by means of a 3-way valve control. The distributor also carried an air compressor, a portable coal oil torch flame, and two coal oil oil-burner nozzles for heating the asphalt when in transit to the street, or maintaining the asphalt at any desirable temperature. An ordinary fan shaped nozzle was used for applying the asphalt directly to the street, the 3-way valve being opened just a sufficient amount to give the desired quantity for the work at hand.

Joint Pouring Rapid Operation.—Three men on the squeegees were all that were required for the street end of the work, the nozzle man and truck driver being furnished with the distributor outfit. These five men handled without difficulty all of the asphalt joint material on this and some other local jobs, without any difficulty whatever and with far less actual work and inconvenience to themselves, and with far less inconvenience to the street residents than is usual in such cases. When the brick surface was laid far enough in advance, it was possible to easily pour three full tanks (700 gal. each) in a single day, and cover in excess of 2,000 yd. of surface. This pouring operation was so fast that the outfit was unable to operate for continued runs of full days, but was required to cut down to two tanks per day quite frequently. Instead of being one of the slow, cumbersome, troublesome operations, the joint pouring became the most rapid operation and least inconvenient on the job.

Advantage of the Method.—Aside from the advantages to the workmen and to the residents, we believe that the advantage to the job was without question a decided one. The material was maintained within a temperature range of less than 250°, regardless of outside temperature and regardless of the amount of material in the tank. It was absolutely uniform in every physical characteristic, no coking or continued overheating changing it in the slightest. By applying directly at the desired point, and following immediately with the squeegees, an excessive amount was not left on top of the brick surface, yet all joints were completely filled. Estimates made on numerous occasions, indicated 1 1/3 gal. or less per square yard of surface.



Unloading Asphalt from Insulated Tank Car Into Distributor Truck

During the progress of the job, sudden summer showers occurred, yet these caused no inconvenience whatever because the pouring operation could be stopped instantly; and on occasions when the rain continued, the distributor was merely drawn back to the yard and the remaining portion in the tank pumped back into the tank car. With this extreme flexibility of operation, the pouring operation could be continued at various points along the job, with only a few seconds' lost time in moving the truck ahead; and a half hour's pouring in one portion of the work required no special set-up and could just as easily be taken care of as a full day's pouring at another section of the job.

Cost of Operation.—The contractor

Applying Filler to Brick Pavement Direct from Distributor Truck. The Asphalt Is Worked Into the Joints by Means of Squeegees

was able to purchase the asphalt in tank cars at approximately $4.00 under the drum price, less 60 ct. a ton for the insulated tank cars. The distributor operator took care of the heating, transportation and applying of the asphalt—including the distributor nozzle man and truck driver—for $12.50 per ton. The three squeegee men were paid $4.50 and $5.00 per day. These items represented the entire cost of this operation on the job. There was no lost labor, even in event of unfavorable wheather, because the three squeegee men could be easily used elsewhere on the job. There was no expense of street heating, and absolutely no expense in the item of clean-up.

From the standpoint of this office, we would say that the work as we had it outlined at the start, proved to be unusually successful, both from the contractor's and city's and the residents' viewpoint. There was no more expense in taking care of the work, and the absolute uniformity, flexibility and dependability of this portion of the job recommend this method, we believe, very favorably to work of this character.

Excess Condemnation Authorized in 11 States.—Excess condemnation is already legally authorized by constitutional amendment or otherwise in 11 states.

$100,000 Traffic Survey for New York.—A traffic survey has been authorized for New York City that is estimated to cost approximately $100,000.

Cost of 48-In. Water Main at New Bedford, Mass.

During 1928 the Water Board of New Bedford Mass., constructed a 2,561-ft. extension of a 48-in. cast iron pipe for a main. The work was done by the forces of the board. The pipe was Class "C" N. E. W. W. A. specifications and cost $38.20 per ton. The following detailed costs of the work are taken from the 1928 report of the Water Board, of which Stephen H. Taylor is superintendent.

	Total	Per Lin. Ft.
Pipe and Specials and Inspection	$31,267.71	$12.21
Leadite and Gasket	881.00	.34
Tools and Repairs	3,879.72	1.51
Labor (see sub-division)	11,324.30	4.42
Fuel, Oil and Grease	1,118.21	.46
Piles and Piling	1,388.58	.54
Akron Tile Drain	1,854.93	.73
Sand, Cement and Gravel	105.40	.04
Culverts Roaring Brook	908.81	.24
Two Wooden Box Culverts	405.62	.27
	$53,134.28	$20.76
Labor Sub-division		
Unload and Distribute 48-In. C. I. Pipe	$ 606.92	$0.24
Excavation and Laying	3,565.21	1.38
Backfill	**3,428.59	1.34
Pumping	758.65	.30
Clearing	469.51	.18
Watchmen	916.21	.36
Repair of Second Hand R. R. Dump Cars	*1,197.10	.47
Miscellaneous—Line and Grade, etc.	382.11	.15

*Four second-hand dump cars purchased for $600 and repaired at an expense of $1,197.10. represent a saving of about $1,500, as compared with the cost of new cars. They have been so thoroughly overhauled and repaired that they are now in every way as good as new.

**This figure includes labor only for that portion of backfill borrowed and hauled by dump cars from gravel pit about one mile from the site. It covers the labor for excavating borrow, loading cars, hauling cars, rehandling with clamshell at the pipe and hand grading. The total borrow was 6,660 cu. yd., and it required 41 working days to handle it. Average cost, labor only, $0.515 per yard; average 162 yd. per day.

Now Building Superhighway at Washington

The newest contribution to the growing exhibit of superhighways and parkways is the Mt. Vernon Memorial Highway, which properly belongs in the latter class, soon to be built between Washington and Mt. Vernon, Va.

The Memorial Highway will be placed on a strip of land 200 ft. wide. At first, a 40-ft. pavement will be constructed, with additional hard surfacing to be laid later when traffic demands it. The roadway will be more than 15 miles long.

Grade intersections with railways and all other heavily traveled roads will be entirely avoided by means of overpasses and under-passes. Further insurance against accidents will be given by the establishment of well-kept dirt shoulders extending 10 ft. on either side of the pavement.

Another modern note will be struck in the construction of seven or eight ornamental bridges. These are to be built to a width of 60 ft., which will preclude traffic jams and accidents common to narrow structures.

By means of fast moving machinery, the highway will be completed by 1932 in time to be dedicated at the celebration of the 200th anniversary of the birth of George Washington. Work of preparing the roadbed has already started.

Landscaping will progress along with the construction work, so that shortly the builders will have achieved their purpose of making the Memorial Highway one of the most beautiful in the world. Neat parking places will be provided between the highway and the Potomac river.

Trees on Watershed Areas

A watershed-protection program initiated by the Denver, Colo., Chamber of Commerce three years ago has resulted in the planting of about 20,000 western yellow pine seedlings on watershed areas close to the city, according to a report to the Forest Service, United States Department of Agriculture. The work has been carried on with the cooperation of various young people's organizations. Last year, for example, 2,000 seedlings were planted by boys of the Order of De Molay in Red Rock Park; 1,000 by the boys of the senior class of Manual Training High School, in Dicks Park; 1,000 by the Camp Fire Girls, on Inspiration Point; and 1,000 by the Garden Club of Denver. The three years' plantings, which have been made in various locations and under varying conditions, show an average survival of about 65 per cent. These results have encouraged the forestry committee of the chamber to develop a program of planting for the whole of the city's watershed.

Essential Requirements for Adequate Street Transportation

A General Statement of the City Traffic Problem

By HAROLD M. LEWIS
Executive Engineer, Regional Plan of New York City and Its Environs

THE highway traffic problem is a new one created by developments of the last 15 or 20 years. Within this period has been the greatest growth in the use of motor vehicles. In 1895 there were only about 300 motor vehicles registered in the United States. In 1915 this had increased to about 2,500,000, and in 1926 the total was over 22,000,000. Today there are probably almost ten times as many motor vehicles used in the streets of our country as there were in 1915. The startling part of this record of growth is that it has not yet shown a downward break. There is now one car for about every five persons in the United States.

This remarkable growth in the new method of transportation has required new developments in the types, number, arrangement and functions of highways. Streets that were previously adequate have now become almost hopelessly congested, and public officials, engineering and other experts, those operating public conveyances, and the motor-riding general public are all trying to find some means of providing adequate facilities.

The traffic problem first proved too much for the old types of roadway surfaces. Waterbound macadam and other light and inexpensive road surfaces have given way to heavier and stronger pavements, not only on the main business streets, but also on that network of trunk line highways which now connects all communities of appreciable size. Only 15 years ago, dusters and goggles as a protection against dust were almost essential parts of the equipment of every motorist, who expected to have to hang on when going over the rough places in order to prevent banging his head against the top of the car. The modern smooth and dustless highway has changed all this in a remarkably short time.

Following the breakdown of highway pavements there came an inadequacy in roadway widths. As a result, trees, strips of parking and wide sidewalks have been sacrificed to permit a widening of roadways and a greater capacity for vehicular traffic. Then, to add insult to injury, we have often doubled or tripled the average heights of the buildings fronting on these same streets, with a corresponding increase in sidewalk requirements, and the excess pedestrians have had to get along on the narrower sidewalks.

In many cases, roadway widening has not proved sufficient, and expensive projects for acquiring adjacent property and increasing the widths of highway rights-of-way have often been necessary. Such costly methods cannot be continued indefinitely. Some way must be found of curing the disease without an ever continued changing of facilities laid out before the motor vehicle era.

There are two principal methods of providing adequate street transportation:

1. Better use of existing facilities.
2. The addition of new types of facilities.

He who argues that only the first of these is needed is short-sighted, and he who would depend only on the latter is extravagant and impractical. Any real solution must be based on both. A brief summary of the most important of the various kinds of facilities in each class may help to indicate how they can be co-ordinated.

Better Use of Existing Facilities

Traffic Control.—The two principal effects of early traffic congestion were delay and an increase in the number of accidents. Traffic regulation and control were instituted to alleviate these conditions. The police department being in most cases already on the job was naturally called upon to aid in such activities. Within recent years the control of street traffic by manual or mechanical means has become a specialty which has received the careful attention of experts in this particular line. The synchronized "Stop" and "Go" system has been followed by various types of progressive systems designed to permit a continuous movement.

Records of the number and speed of vehicles were made by the Regional Plan of New York and Its Environs on typical Manhattan streets in 1924. These included 983 observations over stretches of roadway from four-tenths of a mile to one mile in length. The average weighted velocity of all observations was 11.3 miles per hour. When the velocity exceeded 11½ miles per hour, the average traffic was only about 200 vehicles per moving lane per hour. This was on streets which could have carried from 400 to 750 vehicles per moving lane, depending on the roadway width and obstructions therein. This shows quite clearly that there was a considerable amount of unused street capacity in New York City at that time, which a much greater efficiency should make available.

Maximum speeds permissible have recently been increased on many of our state and county highways, where 35 and 40-mile speed limits have superseded those of 15 and 25 miles per hour. But within our cities what is needed is not so much a greater maximum speed but a greater average speed. What is gained by moving 25 or 30 miles per hour, when traffic stops and delays reduce the average speed to less than that of a pedestrian? At times of peak loads on Fifth Avenue in New York City, average vehicular speeds of 2.5 to 3 miles per hour are not uncommon, and similar conditions are found in other cities.

More study must be given to the intersections and to the movement of both pedestrians and vehicles at such points. The pedestrian has until recently received little consideration.

Truck Loading Facilities within Property Lines.—Establishments which handle a large amount of trucking are the most serious offenders in regard to the use of streets for private purposes. Large modern trucks standing in narrow roadways during the loading or unloading of merchandise are a very serious obstruction to traffic movement. In many cases the merchandise monopolizes the sidewalk space. Many large and enterprising concerns have voluntarily installed loading facilities which permit such trucks to stand upon private property. These concerns have found that the savings to themselves have justified such expenditures. This in itself indicates that the compulsory provision of such facilities would be warranted.

Similar provisions should also be made for passenger vehicles by hotels, department stores and any concerns which cater to large numbers of persons using motor vehicles in going to or from their doors.

Night Deliveries.—Even a casual study of the variation in motor vehicle traffic during the 24 hours of the day indicates the great increase in capacity which would result if the peak loads could be reduced and the traffic spread more evenly throughout the day. There are many types of wholesale products

or large deliveries of coal and other retail products which might well be delivered to the business areas during night hours.

The express companies and other concerns have long realized the savings in night trucking, and have practiced it to a considerable extent. Some large department stores move their goods at night between their main stores and warehouses, and their sub-depots in the outlying parts of the city. A more universal knowledge and practice of this type of service would do much to provide adequate daytime transportation for vehicles which must move in daylight hours.

Consolidation of Trucking.—Considerable reduction in the number of vehicles using the streets may be accomplished by a consolidation of trucking routes and trucking service. This would do away, to a large extent, with the necessity of only partly loaded trucks making their many separate trips to isolated points. Store door delivery by the railroads between their rail terminals and shipper or receiver is a useful type of trucking consolidation which has been practiced successfully in England and Canada. Joint motor truck freight terminals for L. C. L. freight is another method which would do much to reduce the number of trucks upon our city streets.

Parking.—The parking of an owner's car in front of his premises on a little used street presents no hardship to his neighbors or the traveling public, but the wholesale parking in front of anybody's property has brought about a very serious problem in the down-town sections of all American communities. The limitation of parking time by municipal ordinance naturally resulted, but has not completely solved the problem, and has emphasized the need for adequate parking facilities accessible to the business districts.

Street space is too valuable to serve as a garage. In many cases the municipalities have at public expense provided considerable areas for the parking of motor vehicles. In general, the provision of terminal storage garages, by private enterprise on the edges of the business district, seems to be the only real solution of this problem.

The Addition of New Facilities

In our developed communities we must doctor up the present highway system, as best we can, to make it serve the modern requirements. Where opportunity permits the laying out of a new street system, it can be better adapted to the motor age. The percentage of space devoted to streets in the average city is about 20 to 30 per cent and is probably sufficient. The traffic problem has arisen because this space is not properly distributed. The wholesale use of the motor vehicle, coupled with the practice of erecting tall buildings for office and other business purposes, demands that business streets be much wider than residental streets.

The checkerboard street system inflicted over large areas on so many of our American cities did not distinguish between business and residential streets, or through traffic streets and local streets. In many cases residential streets, where the use of the land is permanently fixed by zoning restrictions, can be narrower than they are today.

General Traffic Streets.—The modern street plan should distinguish between traffic streets and local residential or business streets, and design each for its prospective needs. In the residential sections the street which is not subject to the noise and inconvenience of continuously passing motor vehicles has many advantages for residential purposes. The main traffic streets should preferably run in pairs, especially where surface transit facilities are to be provided. What would it be worth to Philadelphia today if Broad St. was paralleled by a street of equal width within a few hundred feet? Many of us have been subject to long detours and delays because a main highway was under repair, and there was no adequate parallel street to which traffic could be diverted.

There is a practical limit to the widths of roadways. Within our cities four or six moving lanes of traffic on a single roadway are about the maximum desirable. Beyond that, an inefficient use of the lanes caused by a shifting of vehicles from one to the other, and the increased difficulty and danger for cross traffic, both vehicular and pedestrian, bring many disadvantages. To get the maximum efficiency of roadway space it should be divided by curbs into sections of a two-lane width, and these subdivided by lines upon the pavement into separate traffic lanes.

On highways outside the city limits, four moving lanes probably offer the most efficient facility, and where greater capacity is required, duplicate roadways are preferable to a single wider roadway.

Boulevards.—Reference has already been made to the reduction of strips of parking which has resulted from increased traffic demands. A comprehensive boulevard system is an asset which every city should attempt to gain and keep. Such streets are essential if cities are to be kept attractive in appearance, and they form the natural boundaries for residential units. A modern boulevard should have a right-of-way of not less than 160 ft., and should preferably be 200 ft. in width.

In many cases, boulevards may partake of the nature of super-highways connecting adjoining cities, such as have been developed in the neighborhood of Detroit, where a 204-ft. right-of-way has been used. Streets of this kind, linked up with by-passes around the larger communities, would form an almost ideal circulation system for long-haul vehicular traffic.

Parkways.—Parkways originally were essentially parts of the park system, and as such were mainly for local use. With the great increase in motoring as a means of individual transportation and as a recreation, the function of parkways has been expanded. As being developed in Westchester County, New York, parkways serve four purposes:

1. They provide park space for local recreation, and connect up large park areas which serve as country parks.
2. They serve as corridors of open spaces between built-up communities, and help to maintain the integrity of suburban centers with local interests and activities.
3. There are constructed through them highways reserved for passenger vehicles, and providing a pleasant and speedy means of travel between the metropolitan areas and the open country.
4. When coupled with proper zoning restrictions, they stabilize high class residential developments in attractive surroundings.

Grade Separation.—It has already been pointed out that traffic interference at street intersections is the primary cause of the inefficient use of existing roadways. This can probably be relieved to some extent by improved methods of control and better design of the intersections. A sure cure can be obtained by the separation of highway grades so as to permit uninterrupted movement in all directions. Unfortunately this method is often so costly in highly developed areas as to be prohibitive. But at certain key locations it may be expedient although costly. There are many places on the outskirts of the congested districts where such a method could be carried out at important intersections at a reasonable expense.

Realizing the great advantages of grade separation, the Topographical Bureau of the Borough of Queens, New York City, has advocated the future separation of grades by the depression of one of the roadways at many important crossings. To facilitate this, they propose the immediate acquisition of a "width of right-of-way from 130 to 160 ft. for a distance of from 300 to 500 ft. on each side of the highway intersection, for the road which is to be depressed."

Zoning and Its Relationship to Highway Facilities

Building Bulk and Highway Traffic.—Intensive building cannot be carried out over large areas without causing an impossible traffic burden on street systems already fixed by existing developments. Zoning offers about the only hope of keeping such building operations within suitable limits. There is obviously a relationship between the bulk of buildings that can be placed in a given area and the capacity of the

streets which serve as a means of access to them. Buildings of large bulk must be balanced against extremely low buildings or open spaces. But vehicular traffic caused by any building is not directly proportional to its bulk, as its type of use is an important factor. Mr. Ernest P. Goodrich, Consulting Engineer, has worked out figures showing that the relative vehicular traffic to and from buildings used for retail business, garment industry in loft buildings, and offices varies in the ratio of 4 to 12 to 21.

That this situation is realized by business and industrial leaders as well as city planners is indicated by the following quotation from an article by Mr. Irving T. Bush, president of the Bush Terminal Company, New York City:

"The sensible thing to do is to limit the floor area on each given plot. This can be done either by establishing a uniform, maximum height of building or by permitting an irregularity of height, but with the provision that a no greater number of square feet of floor space be permitted upon each lot."

An analysis by the New York Regional Plan staff of the relation between building bulk and highway traffic in southern Manhattan, New York City, indicated that if every land owner in this district were in the near future to erect buildings merely to the cornice heights, as permissible under the zoning law, there would be a volume of local traffic nearly 70 per cent in excess of that which it is estimated the streets could carry. And the setback and tower provisions of the New York City Zoning Resolution permit building bulks far in excess of those used in this computation. Therefore, if the present street system in Manhattan is to serve the buildings within the business sections, some way must be found of keeping the average height within those areas well below that now legally possible.

Influence of Land Uses.—There is a tendency to consider every arterial street as a potential business street. In many cases they have been zoned throughout for business. The result has been that property fronting on such streets has been held by real estate dealers at prices prohibited for residential purposes, and residences have first been built upon those side streets where more economical lots could be obtained. The development of property along the arterial streets has thus been held up until a sufficient residential development had taken place in the neighborhood to justify the construction of business buildings.

A more economical arrangement might have been obtained by designating certain isolated sections of the main street for small business centers to serve local residential communities. The balance of the avenue might well have been zoned for residence, with a sufficient set-back line to assure that the houses would be far enough removed from the noise and dust of the vehicular traffic to provide satisfactory places of residence.

Set-back lines are particularly valuable along streets which may later have to be widened as the area builds up and traffic increases. They permit such a widening without the costly and often prohibitive expense of tearing down buildings.

A Plan for Adequate Street Transportation.—While all cities have their traffic problems which contain many similar elements, no two cities are exactly alike, and therefore there is no standardized cure which can be applied. There are standard principles which will be of help, but their application is necessarily different. It is therefore essential that, before a plan can be adopted to provide adequate street transportation for a given community, a careful traffic survey be made for that community. The type of material to be included in such a survey is beyond the scope of this paper, in which an attempt has been made to set down some of the methods of solution which should be considered in drawing up a comprehensive plan for vehicular traffic after the survey is completed.

As has been pointed out, such a plan should combine (1) the improvement of existing facilities by new regulations, supplemental additions and such changes in existing facilities as may prove economically feasible with (2) the addition of new traffic routes adapted to modern requirements, and designed to provide for estimated future needs.

A properly prepared zoning plan can be of inestimable advantage to any community. By a careful co-ordination of its provisions with the traffic plan, it can do much to maintain a proper relationship between the buildings within a city and the streets which must both serve those buildings, and also permit an easy flow through the city of all that vehicular traffic which modern ways of living and doing business bring within its gates.

Acknowledgment.—The foregoing is a paper presented at a symposium on "Expediting and Controlling City Traffic," held under the auspices of the Engineers' Club of Philadelphia.

Percentage of Rural Population Declines.—In 1880 our rural population formed 71 per cent of the total; in 1925 the proportion was only 45 per cent. Yet there are 18,000,000 more people in the rural districts of the United States today than there were 50 years ago. Farm acreage has increased from 536,000,000 to 924,000,000, and the value of farm property is nearly five times as great as it was in 1878. Half a century ago the value of all American farm products was less than $2,250,000,000 yearly—while by 1925 it had risen to more than $13,000,000,000.

Public Purchases of Materials for Municipal Work

To the Editor: In you issue of November, 1928, I note an article on "Public Purchase of Materials for Public Works" to be furnished to contractors.

It may be of interest to your readers that the Metropolitan Water District of Manila, Philippine Islands, used these methods for many years, on certain classes of materials, especially since the extension of our system which was started a few years ago, and which will cost some eight or nine million dollars, went into effect.

Our procedure varies for various materials and is approximately as follows:

Cement: We buy large quantities of cement and test it for our own account and deliver it to the contractors at our storehouses, at practically cost price. The contractor transports it to wherever it may be needed at his own costs, and stands all losses due to damage, etc. In his charges per cubic meter of concrete, he naturally includes the cost of the cement. Cement used up every half month, as per his report verified by our engineers, is deducted from his 15-day estimate of work accomplished.

Cast Iron Pipe, Specials, Valves, Etc.: We buy ourselves under separate arrangements, and the contractor is paid whatever he bids, per ton, for transportation from our yards, installations, etc. If any material is damaged, through contractor's fault, we charge him the cost of materials.

Steel Plates for Pipes, Etc.: We purchase the plates to our specifications, and pay contractor for transportation, manufacture and construction. We intend to do this in the future with reinforcing steel, whenever large quantities are to be used. The drainage pipes for our filter system were drilled and plugged in our own shops and delivered to the contractor ready for use. We find it very advantageous, as we can secure lower prices in purchasing materials, borrow our money at about 4½ per cent, while the contractors here would have to pay 9 per cent per annum, and can buy the material we wish and avoid arguments with the contractors. The contractor is helped out considerably as it reduces his financing troubles, and does not have to worry about his materials.

We never had any trouble about non-arrival of materials on time, as we make sure to order the materials before they are needed.

A. GIDEON,

Manager and Chief Engineer, Metropolitan Water District, Manila, P. I.

Purifying Acid Mine Water

The Kaplan-Reger Process

THE West Virginia Geological Survey has recently completed a process for the purification of acid coal mine waters. Generally speaking, it consists in adding to the sulphate waters from coal mines a complex organo-metallic compound which combines with the chemical compounds of the waters and forms a blue pigment to be known as Monongahela Blue and at the same time removes the acid. By certain mainipulations the color of the pigment may be varied almost at will, producing beautiful shades of blue, green, and red. These are not aniline dyes, but are mineral pigments.

Numerous Variations Possible.—Numerous variations of the process are possible and it has not been determined which of these several manipulations may prove to be most successful or profitable, but in general the use of the process at any given point will depend on whether water purification alone is desired or whether the recovery of chemical by-products is the main consideration. In the first case, if purification is the main object, the original cost of the reagent need be no obstacle. The pigment recovered has at present a market value approximately 100 per cent greater than the reagent added and would normally be sold at a profit. If more pigment should be manufactured than can be absorbed by the market, however, it could be decomposed with the regeneration of the organo-metallic reagent and another pigment of less value recovered. By this method the organo-metallic reagent would be used many times with only a trifling loss on each operation. In the second case the more highly saturated waters would be treated for commercial recovery of Monongahela Blue and other products and water purification would be incidental although very effective.

Detailed Studies Necessary for Different Localities.—In order to determine the most practicable method of handling mine waters in different localities it will be necessary to make detailed chemical studies at all such points so that particular recommendations can be made regarding what can be done. The experiments so far made have been confined to certain mines in the Scott Run region near Morgantown, where conditions appear to be specially favorable for use of the process. It is believed, however, that the waters derived from the Pittsburgh coal of the Monongahela Valley in West Virginia, and from the same coal mine waters in western Pennsylvania and eastern Ohio will prove suitable for use in strictly commercial plants at many favorable points. So far as observed the water from the Sewickley coal has proved to be alkaline and not readily susceptible to this method of treatment. At the same time, however, this water is much less corrosive and therefore less objectionable in the streams, its principal impurities being calcium and magnesium sulphates which make it hard and troublesome for laundry and bathing purposes.

In regions where the sulphur content of the coal is very low it is not at present supposed that enough chemicals exist in the mine waters to make treatment either necessary or profitable, but further exhaustive study will be necessary to establish or disprove this theory. The Geological Survey has no present plans for work on low sulphur mine waters, as its funds and personnel are too limited to engage in a general investigation outside of the high sulphur districts.

Recovery of Chemicals Commercially Possible.—In the high sulphur regions where mine waters are acid it is believed that the recovery of chemicals will prove to be so profitable that their exploitation will be pushed by the larger mining or chemical companies to the great advantage of those concerned either by way of mine water ownership or by participation in these manufacturing enterprises, and also to the almost equally great advantage of the communities which must now make domestic use of these polluted waters. It is expected that the Monongahela Valley of West Virginia, in particular, will be specially benefited by the discovery.

The study of coal mine waters has occupied the attention of industrial and public health chemists for many years, but in general their conclusion has been that no profitable process for utilizing these dissolved chemicals could be devised and that little could be done toward purification except to neutralize the acids by the addition of lime which at the same time makes the water hard and in some respects more objectionable. Federal chemists have estimated that four or five tons of water are produced for each ton of coal mined and that in Pennsylvania alone 9,000,000 tons of sulphuric acid are dumped annually into the streams. In the Monongahela Valley of West Virginia chemists of the university have figured that the acid mine drainage of 50,000,000 gal. per day. On the basis of 200 grains of acid per gallon the river receives about 250,000 tons of acid annually. These figures give some idea of the pollution problem.

How Process Was Discovered.—In 1919 David B. Reger, now Acting State Geologist, collected a few samples of mine waters on Scott Run and had them analyzed in the laboratory of the Survey in the hope that some profitable use might be made of them, but no such result was achieved, as the Survey was then poorly equipped for such an investigation. In the summer of 1928, after he had become its acting head, the Survey installed a new chemical laboratory with facilities which made possible a resumption of the study. In August of that year Mr. Reger and Dr. B. B. Kaplan, chemist of the Survey, again began the collection of acid mine waters, which were then subjected to exhaustive analyses and experiments by Dr. Kaplan, resulting in the rapid development of the process above mentioned. To those who have been permitted to witness the production of Monongahela Blue and other valuable compounds by Dr. Kaplan in his laboratory the results are declared to be a brilliant achievement of unusual merit, capable of bringing to West Virginia a valuable chemical industry and at the same time ridding the state of a grave menace to its water supply.

For convenience it has been styled the Kaplan-Reger Process, giving first honor to its chief technician, Dr. Kaplan, and at the same time recognizing the original conception and personal cooperation of Mr. Reger. Patents are now pending in Washington to cover the process, as it is not considered advisable to permit indiscriminate or irresponsible chemical manipulations on water which may be used for city supply at some down stream point. Under proper chemical supervision there is no danger that any deleterious agent may enter the water. On the contrary the dangerous compounds now in it will be entirely removed. At some later date a detailed scientific description of the process will be prepared for the technical journals.

The Kaplan-Reger Process differs fundamentally from all other methods of treating acid water. In general the practice has been to use the so-called base exchange method which consists in substituting a less objectionable chemical for one which is distinctly injurious. This method is expensive and unsatisfactory since the chemicals are always lost and no by-products are recovered and since the highly saturated water foams in boilers and is otherwise troublesome to use. In the Kaplan-Reger Process, however, the added chemicals combine completely with the chemicals in the water to form an insoluble, marketable product, leaving the water practically free from acid and mineral substances.

Florida Water Works Men Meet in April.—The next meeting of the Florida section of the American Water Works Association will be held April 10 and 11, 1929, at Jacksonville, Fla. E. L. Filby, Chief Sanitary Engineer, State Board of Health, Jacksonville, Fla., is secretary.

The Sewage Disposal Plant of Aurora, Ill.

Design and Construction Features Outlined

By L. R. HOWSON

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THE Aurora Sanitary District was organized in 1926. The district boundaries include all of the city of Aurora and a small area outside. Quite recently, the district has been extended to the south along the Fox River in the village of Montgomery.

All of the sewage of this district drains to the Fox River, which flows diagonally through the center of the city. There is no sewage treatment now, with the exception of the Indian Creek District in the northeast section of the city, where in order to obviate the necessity of constructing an outlet sewer through deep cut, the city of Aurora constructed an Imhoff tank, the effluent from which discharges into Indian Creek and thence to the river.

While the flow in the Fox River exceeds 200 cu. ft. per second for approximately 97 per cent of each year, local nuisance has resulted from time to time and the objectionable appearance of the river due to the discharge of the raw sewage is noticeable a considerable portion of each year.

Soon after the organization of the district, engineers were employed to make a comprehensive study of intercepting sewers and sewage disposal. The investigation was made during the latter part of 1926 and the report was transmitted in March, 1927.

Population Study.—The total population residing within the district at the present time is approximately 50,000 people. The growth in population in the past has been relatively slow and gradual but in recent years, due to the influence of the Chicago suburban expansion and the greater industrial development of the district itself, the growth has been more rapid. It is believed that the population will approximate 75,000 people by 1940, 105,000 by 1950 and 170,000 by 1970.

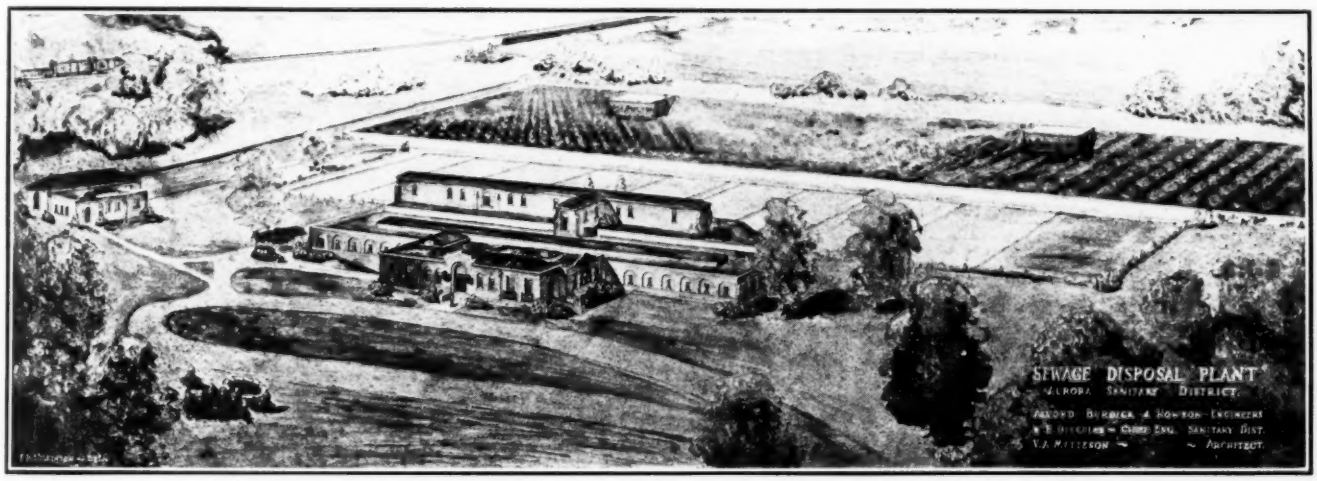
The dry weather sewage flow at the present time is approximately 5,000,000 gal. per day, which it is estimated will increase to 7,000,000 gal. per day in 1940 and from 9,000,000 to 10,000,000 gal. per day in 1950. Analyses made of the sewage and of the wastes from the principal industries showed that it is what is usually termed "typically domestic." The industrial wastes are of relatively small importance as measured by their quality and the necessity for special treatment.

Period of Design.—In the making of the investigation, it was believed that intercepting sewers, which, for a considerable portion of the distance, must necessarily pass through the business district of the city which adjoins the river on either side, should be designed for the 1970 population of about 170,000 people.

Sewage disposal works which can be constructed on the unit plan were designed to care for 75,000 people and 6,500,000 gal. per day, the conditions forecasted for 1940.

Disposal Plant Site.—In the selection of a site for the disposal plant, the choice was largely dictated by topographical features. The low lying land in the Fox River Valley is usually limited in extent and the first available site downstream from Aurora was in close proximity to the village of Montgomery. An excellent site existed about one mile south of Montgomery, in which sufficient low lying land was available, not only for present requirements but for the indefinite future. Approximately 26 acres were purchased for the first construction. This site is about two miles south of the south limits of Aurora.

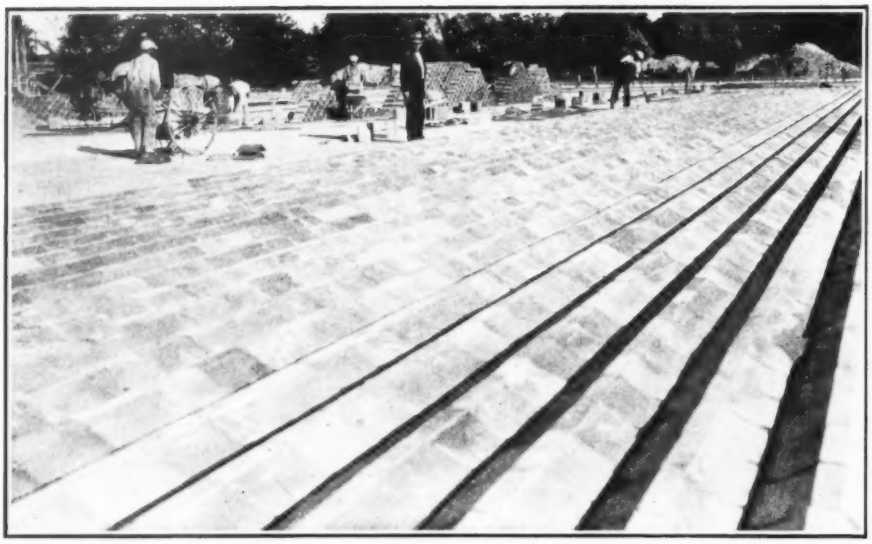
Intercepting Sewer.—The intercepting sewer is approximately 32,200 ft. in length and varies in size from 18 in. to 69 in. So far contracts have been let for 12,260 lin. ft. of 69-in., 6,270 lin. ft. of 54-in. and 370 lin. ft. of 48-in. Bids have been taken upon segment block, each bidder being required to submit a proposal on at least two types of manufactures of block. All of the sewers built to date have been constructed of the Meier block.



Perspective View of Sewage Disposal Plant of Aurora Sanitary District, Aurora, Ill.

The Meier block is a pre-cast segment block tile. The segments are single ring, vitrified tile which are formed on the bank into tile sections about 4 ft. in length. Adjoining segments have interlocking lugs which are filled with cement grout and which provide the strength necessary to hold the tile in circular shape. The tile are handled and laid in a manner similar to ordinary concrete pipe. Joints between adjacent tiles are made with cement mortar.

The experience with the Meier block to date has been quite satisfactory. The only difficulty experienced has been due to the unequal burning of the segment blocks and the variations in block, shrinkage resulting from this fact. This has, however, not been a serious difficulty, simply resulting in the necessity of using more mortar at the joints between adjoining lengths. The invert of the sewer is unusually uni-



Placing Sprinkling Filter Bottom

form as all irregularities have been taken in the top of the joint. All tile are bedded in concrete up to the springing line.

The sewer excavation has been attended by no unusual difficulties other than those incident to work of this type. It was necessary to remove approximately 7,000 cu. yd. of rock from the trench excavation. The sewer trench which parallels the river, practically the entire distance, has not involved an excessive amount of pumping, the invert of the sewer in its lower reach being slightly above river level for most of the distance.

The work to date has involved three river crossings which have been effected by the use of cast iron inverted syphons, each syphon being in duplicate or triplicate with inlet and outlet chambers so arranged as to maintain as high velocities as possible in each line in service before another line is added. Provisions are made for the blowing-off of any deposit that may accumulate in the syphons.

The sewer contracts have been let at low figures, the prices and the average cuts being as follows:

Size	Per Ft.	Average Cut. Ft.
69-in. sewer	$14.95	8.0
54-in. sewer	13.75	9.25
48-in. sewer	7.75	8.5

Manholes are of concrete and were bid at prices varying from $82.50 to $100.

Plans are now nearing completion on the additional interceptors, approximately 850 ft. of which will be of 36-in. cast iron pipe laid largely in the river bed or immediately adjoining it and below river level.

Sewage Disposal Plant.—In the preliminary investigation comparative studies were made of those means of sewage disposal ordinarily adapted to Aurora conditions. As a result of that investigation, a plant consisting of coarse screens, grit chamber, tanks of the separate sludge digestion type with mechanical equipment, sludge drying beds, pumping station and sprinkling filters was determined upon. Bids were taken in the early summer of 1928 and the work is now well over half completed.

Screens and Grit Chamber.—The coarse bar screens are of the mechanically cleaned type. The screen consists of steel bars ¼ in. by 3 in. spaced at 5/6 in. centers and with a raking device automatically controlled by the difference in water level ahead and behind the screen. As the screen becomes clogged, the cleaning apparatus makes one revolution, raking the material to a platform at the top, from which it is shoveled directly into a car.

The sewage after passing through the screen passes into a grit chamber which is of the mechanically cleaned type. The screen chamber is approximately 26 ft. square and has a normal water depth of 2 ft., giving a theoretical detention period of 2¼ minutes. The grit as it settles out is collected by a revolving mechanism of the clarifier type, but with squeegees so arranged as to push the grit to the periphery instead of the center of the basin. The grit is pushed out into the bottom of an inclined elevator provided with a mechanism which tends to carry the grit up an incline and wash out the organic matter which flows back into the sewage and thence through the plant. This grit is loaded into cars and used for filling. It is expected to be practically free from organic matter.

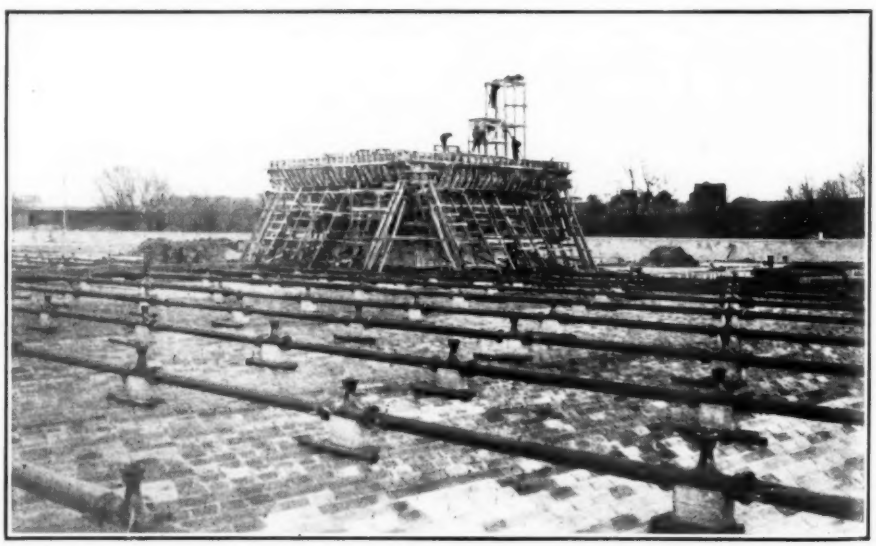
The mechanical screen and the grit chamber apparatus are furnished by the Dorr Co. The cost delivered, but not installed, is $2,450 for the screen and $5,600 for the grit chamber equipment.

The screen and grit chamber are housed in a superstructure of general architectural design similar to the office, pump house and tank structure.

Tanks.—From the grit chamber, the sewage flows through a 48-in. sewer provided with a venturi meter to the settling tanks, which are four in number, each 50 ft. square by 11.5 ft. deep and which provide a detention period of three hours at the normal rated flow of 6,500,000 gal. per day. These basins are provided with Dorr Co.'s traction clarifiers. The tanks are provided with skimming devices for grease removal. This grease is pumped to a decantation tank in the screen house, where after separation from the water it is disposed of with the bar screenings.

The sludge is pumped from all tanks by a single sludge pump which discharges into any one of three sludge digestion tanks, each 50 ft. square by 16 ft. deep, the floor of which is placed approximately at the ground surface. These tanks provide capacity equivalent to 1.9 cu. ft. per capita served in 1940.

Gas from Digestion Process Used for Heating.—The sludge digestion tanks are covered with a concrete roof which is supported by the digester mechanism trusses and the exterior walls. The roof slopes toward a central gas dome



Sprinkling Filter, Floors, Dosing Tank and Distributors

3.6 Acres of Sprinkling Filters; Bottom and Pipe Supports Set in Background

4 ft. in diameter by 3.5 ft. high which is connected by gas piping to an ordinary gas fired hot water boiler located in the main building. The gas resulting from the digestion process will be collected and used for heating the main building and for heating water which will be circulated through the digesters to maintain as uniform and as high a temperature as practicable during the entire year.

The top of the digesters is covered with an earth fill and an embankment of earth surrounds all exposed walls. This is to assist in maintaining uniform temperature for digestion.

Each digester has a separate gas meter and all piping is so laid out as to permit of maximum flexibility of operation.

Sludge digesters may operate in parallel or series. All pumping and circulating operations are controlled from a central point.

The settling tanks which occupy an area of 50 ft. by 200 ft. are covered by a low housing of brick with stucco exterior and with a creosoted wood roof supported on steel trusses.

In plan, the pumping station, the settling tank superstructure and the sludge digestion tanks all adjoin and the superstructure is so designed that access to this entire part of the plant is had without going out of doors.

Pumping Station.—From the effluent channels of the settling tanks, the sewage flows to a suction well approximately 12 ft. by 51 ft. by 9 ft. deep. The sewage pumps, consisting of three units respectively of 6,000,000 gal. daily capacity and two of 8,000,000 gal. daily capacity, take suction directly from this well and discharge the sewage through cast iron force mains to the two twin dosing chambers. Operation of pumps is automatically float controlled. Due to the necessity of pumping settled sewage only, it is practicable to use closed impeller pumps with the resulting greater efficiencies. Each dosing chamber serves 0.9 of an acre of stone sprinkling filters. Each chamber is provided with a 24-in. single syphon.

Sprinkling Filters.—The stone sprinkling filters have a total area of 3.6 acres and an average depth of 6 ft. At the time bids were taken, alternate bids were received upon three types of underdrainage, namely, a valley and trough type of plain concrete floor, the "Rawn" underdrainage system and the "Metro" underdrainage system. As would be expected, the concrete underdrainage system was the cheapest. The Metro system bid was $9,600 per acre higher than the plain concrete and the Rawn system $11,700 per acre higher than the plain concrete The Metro system was adopted. The experience in laying this floor has been very satisfactory.

Contractors were required to submit samples of filter stone for testing. All samples were tested for soundness and ability to withstand alternate freezing and thawing, using the salt method, the immersion withdrawal and freezing method and the submerged freezing method. Of ten samples tested, but four satisfactorily met these tests which were conducted over a period of several weeks by the Engineering Service Company of Aurora.

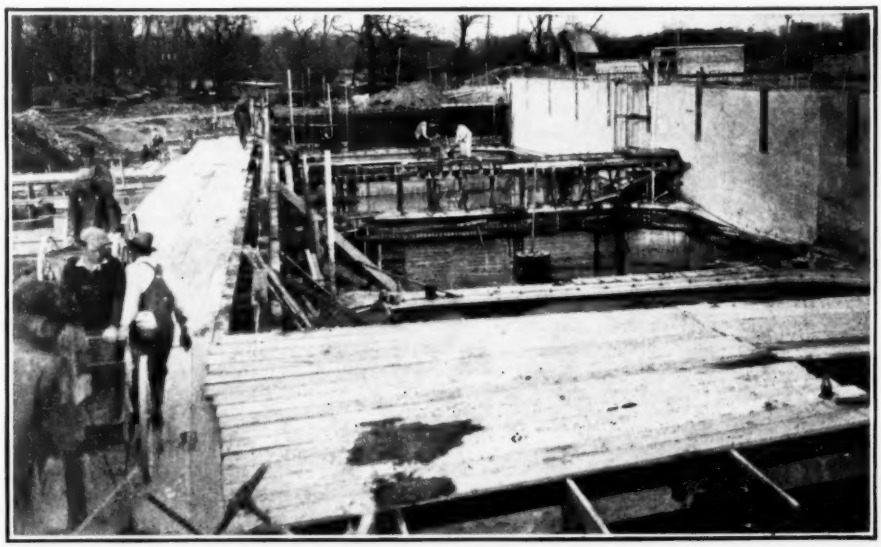
Pumping Station and Office Building.—The pumps are housed in a Spanish style building which is a part of a general structure housing the tanks proper. The pumping and administration building has a floor area of 42 feet by 76 feet. The building includes an office and laboratory, public toilets, switchboard room, heater room and two car garage. The exterior finish is of white stucco on rough brick. The roof is of Spanish tile.

Concrete Surface.—The specifications required that all concrete surfaces exposed to view should be rubbed while the concrete was still fresh with a carborundum brick. The effect thus produced has been unusually good. The writer is indebted to L. N. Fisher of Cope & Fisher of Decatur, Ill., contractors on this work, for the following construction outline:

"Various methods and times of producing the finished surface were tried. As eventually worked out, the forms are stripped in from 12 to 36 hours after pouring, all depressions and voids are then pointed up and a bush hammer is used to take off the worst of the form fins, although all ordinary form marks are left for the machine.

"In from 36 to 60 hours after the concrete has been poured, the entire surface is gone over with an air driven grinding machine. Two men are used on each machine, one to operate the machine itself and the other throwing clear water in front of the machine and pointing up with a trowel and hand brick after the machine."

The contractor advised that the cost of this finishing is from 9 ct. to 11 ct. per square foot of surface which is equivalent to about $2.50 per cubic



Pump Pit at Extreme Left; Clarifier Tanks in Center; Sludge Digesters at Right

yard of concrete based on a 12-in. wall thickness.

Mr. Fisher further advised that the best results are secured when the temperature ranges from 65 to 75 degrees. Higher temperatures result in the surface drying too quickly and with lower temperatures, the concrete does not finish up well behind the machine. If the concrete is allowed to go as long as 5 or 6 days before finishing the surface, the cost is increased approximately 100 per cent.

It is the writer's conclusion that the extra cost of this method of surface finish is well worth while. Relatively so small an amount of an intercepting sewer and sewage disposal plant construction is above ground that it is desirable to make that part as attractive as economically practicable.

Personnel.—The preliminary report, plans and specifications for the Aurora work were prepared by Alvord, Burdick & Howson. Mr. W. E. Deuchler, Chief Engineer of the Aurora Sanitary District, is supervising the construction through the Engineering Service Company of Aurora. Cope & Fisher of Decatur are contractors on the disposal plant. The intercepting sewers are being built by Ashton & Russell of Chicago and Kuehn Bros. of Aurora.

Acknowledgment.—The foregoing is a paper presented Jan. 23 at the 44th annual meeting of the Illinois Society of Engineers.

Elimination of "Red Water" with Soda Ash

After the completion of the new rapid sand water filtration plant at the Maryland House of Correction, at Bridewell, Md., considerable trouble was encountered with "red water," and tests were made to discover the cause. The recently issued report for 1928 of Abel Wolman, Chief Engineer Bureau of Sanitary Engineering of the Maryland State Department of Health, contains the following note on this work:

The tap water was found to contain appreciable amounts of free carbon dioxide and a hydrogen-ion concentration that was well on the acid side. Tests were made using sodium aluminate together with alum for coagulation and doses of 0.7 grain of alum and 0.2 grain of sodium aluminate per gallon were established. However, this did not entirely remove the trouble and further tests with lime and soda ash were made. Lime or soda ash treatment removed the carbon dioxide and increased the pH, but as the treatment with lime was less satisfatcory, due to the variable strengths of milk of lime and the danger of increasing the scale forming solids, treatment with soda ash was recommended. The recommendation was carried out and all trouble with "red water" was eliminated and improvement in the taste of the water was reported.

Cleveland Gets First Airport Convention

The first airport convention ever held will be staged in Cleveland, O., May 16, 17, 18, according to an announcement made today by Captain Clarence M. Knox, vice-president in charge of the Airport Section of the Aeronautical Chamber of Commerce. Mr. Knox, who is Commissioner of Airports of Connecticut, with headquarters at Hartford, said the airport convention would be an annual affair. His announcement follows:

"The Airport Section of the Aeronautical Chamber of Commerce will hold the first airport convention ever held, in Cleveland, May 16, 17, 18. A tentative program includes discussions and addresses on various phases of airport lighting, landing field construction and care, inter-field communication and meteorology, design and architecture, safety control, maintenance and administration, and standards of practice.

"In addition to the large attendance among representatives of airports from all parts of the United States," Mr. Knox said, "the convention will attract representatives of municipalities and civil organizations, engineers, architects, contractors and manufacturers whose interests in airport development and construction are assuming great proportions." The following have been appointed on the convention committee:

Chairmen:—Local Convention Program—Major John Berry, Manager, Cleveland Municipal Airport; Entertainment—B. E. Fulton, Manager, Fulton Field, Akron, O.; Registration—Gabriel C. Harmon, Manager, Trans-Continental Airport of Toledo; Membership—Clifford Henderson, Director of Airports, City of Los Angeles; Demonstration—E. A. Johnson, Operator Dayton Airport; Program—Harry Schwarzschild, Publisher Airports; and R. W. Whitney, Manager, Airport Section, Aeronautical Chamber of Commerce.

Information on any feature of the convention may be secured by writing R. W. Whitney, Aeronautical Chamber of Commerce, 300 Madison Ave., New York City.

Phenol Treated in New Way

The Ohio State Department of Health, according to its official publication, Ohio Health News, of March 1, has recently completed a preliminary report of an inspection of the by-product coke plant and phenol treatment works of the Pittsburgh-Crucible Steel Co. at Midland, Pa. This report is a result of one of the important departmental activities under the Ohio River Stream Conservation Agreement which is to conduct joint investigations, with representatives of other interested states, of industrial plants which discharge waste water into interstate streams or their tributaries, thus affecting down-stream water supplies.

The plant of the Pittsburgh-Crucible Steel Company is situated on the Ohio river immediately upstream from the Ohio-Pennsylvania state line and the water supply intake of East Liverpool, Ohio. The phenol-contaminated waste water from this plant, discharged to the Ohio river directly, formerly affected the East Liverpool water supply very seriously. This situation was brought to the attention of the State Department of Health of Pennsylvania by the Ohio Department of Health, and after due investigation an order was issued to the company by the Sanitary Water Board of Pennsylvania to correct the situation. As a result, this company has constructed a phenol treatment works using the Heffner-Tiddy process. This treatment works has been in operation since May 1, 1928, and it is stated that an efficiency of phenol removal of 90 to 95 per cent has been effected. In this case, the proof is in the drinking of the East Liverpool water, and in justice to the company it must be stated that so far the supply has been comparatively free from phenol tastes and odors.

It is to be noted that the waste water from the plant at Midland does not affect any water supply in Pennsylvania. The correction of this industrial waste problem was carried out at the insistence of the Pennsylvania Sanitary Water Board solely for the purpose of protecting water supplies in Ohio, West Virginia and other downstream states. The correction of this problem demonstrates the workability of the Interstate Stream Conservation Agreement on the Ohio river and indicates the benefits that may be derived by handling such matters in a co-operative manner with uniform administrative methods and policies.

Pocket Gophers Dig Up Airport

One of the finest municipal airports on the southern border, located at Douglas, Ariz., recently became infested with pocket gophers, which threw up more than 2,000 mounds of earth on the field, making the landing of planes difficult. The field is unique in that its southern border is the international boundary line between the United States and Mexico. The aviation committee of the city of Douglas requested the assistance of the Bureau of Biological Survey of the United States Department of Agriculture in clearing the field of pocket gophers and provided a crew of men to place poison and traps. Three days' work under the supervision of the bureau's leader of rodent control in Arizona resulted in complete eradication. The control operations were conducted in cooperation with the Arizona Agricultural Extension Service.

City Planning in Colleges.—There are now six colleges in this country giving city planning work as liberal arts work.

The Development of Traffic Control Engineering

New Field Offers Opportunities for Engineers

By MILLER McCLINTOCK

Director, Erskine Bureau, Harvard University, Cambridge, Mass.

THERE is probably no field of professional activity developing so rapidly as is engineering. The very great increase in the complexity of modern life, and especially in technical methods for accomplishing new results, has brought many new opportunities to the engineer during the last quarter of a century. Those who were connected with engineering practice twenty-five years ago see today the inclusion of many subjects which were never formerly contemplated as engineering problems. In no aspect are the complicated elements which come under the engineers' jurisdiction changing more rapidly than in American cities. The problem of street traffic is just one of many of the rapidly shifting conditions in current urban life. It is another instance of the important public problems which arise and need the kind of attention which engineers have been trained to give to problems of this character.

I am not going to give a technical talk tonight, or a formal one. I am going to think more or less out loud, and to tell something of the experiences I have been having the past few years, with the hope that I can give some idea of the breadth of the problem and of its character.

The Traffic Problem.—In the first place I would like to outline to you just a little bit what the traffic problem is, because while you are in the midst of it constantly it is very difficult to vizualize its influence on social life unless you have really studied it. The problem of traffic as illustrated in the streets and highways of American cities is the problem of unbalanced supply and demand, or of too great pressure in a carrying system which we have at present. We must operate arteries of travel over the street and highway systems which we have, and this is a problem, particularly in the case of such highways as have expanded very rapidly during the last few years, but which are connected with streets where the expansion has been slow.

The street system in the central part of Boston is practically identical with that laid down 100 years ago; in many parts with that of 150 or 200 years ago. It was originally designed for the needs and requirements of community necessities for travel of a small colony, using a very different type of transportation than we find it necessary to use today. We have built up on that very inadequate street system a tremendous metropolitan system, similar in size to many large cities throughout the country, and then we attempt to pour through it hundreds of thousands of people where only ten or a score or so were intended to move in the first place, and also to move them by very special type of transportation.

Problem Not New.—This is not a particularly new problem in American cities or in the city of Boston. I suppose one of the most acute traffic situations in this city was in the 90's, when traction lines were operating on Tremont and Washington Sts. As some one very aptly wrote, "We have changed the quiet streets of the city of Boston into a situation of chaos where quiet streets no longer prevail and where electric monsters crush out human lives . . .," etc. Those electric monsters have disappeared underground, which has been a temporary traffic salvation, but in the past quarter of a century the old methods of travel, particularly by means of mass transportation, have changed. We have added a torrential flood of motor vehicles.

I know of nothing so striking in the change of physical habits as the manner in which the American people have adopted, absorbed and utilized motor power. We are accustomed to hearing this past quarter of a century referred to as the age of the development of flight. We might with equal reason refer to it as the age of development in the use of the motor vehicle. It was only a quarter of a century ago that it came to stay. In that short period of time not only has the motor car developed to the efficiency of the greatest mechanical refinement, but it has been so rapidly reduced as to price of production that practically every one can own one. Almost every student of mine has at least a Ford, and I know that out in Los Angeles at least, Fords can be picked up for $25, for $15, and cars that will run, all the way down to $5. Every citizen can own a car, and they do in increasing numbers.

This last year in the United States showed a registration of about 24,000,000 automobiles—twenty-three and a half million, to be exact. Thirty years ago there were none. There are only 29,000,000 cars in use in the entire world. We have approximately 24,000,000 of them in the United States. This has changed all the transportation systems and has brought with it a problem of a very weighty character. I should like to indicate very briefly some complexities of the traffic problem as found in the typical American city.

In the first place there is the definitely social problem of automobile accidents. There were killed in the United States last year, in automobile accidents, 27,000 persons, and about 700,500 persons suffered serious personal injuries in automobile accidents. This is in excess of 1½ per cent of the entire population, to say nothing of the tremendous capital and financial loss sustained through automobile accidents. The social problem is, therefore, one of the greatest importance, and a very definite problem in connection with traffic control throughout the country. It is being met by various agencies, but unfortunately few seem to be able to make much impression on this particular part of the problem.

Economic Factor of Traffic Problem.—The second part is the economic factor, and this also is a very serious one. The cost of living and the cost of commodities depend to a very great extent upon local transportation charges. The cost of trucking within cities may amount to as much as 150 per cent of the total external transportation charges. It may cost one and one-half times as much to bring the product to the ultimate consumer as it does to bring it from its place of production to the city. Transportation has also an effect on the location of mercantile concerns. This matter of location is dependent to a very large degree on traffic congestion. It causes what we call the decentralization phenomenon, or the tendency for business to move outward. People in Boston have seen the very rapid and spectacular growth of the Park Square district, for instance. Only a few years ago there were very small and unimportant buildings located there. Today it has become an important retail center, with large buildings. This is an evidence of the tendency of business to grow outward whenever the accessibility of the location is hampered in any way. Every merchant appreciates the importance of accessibility to his business. If his store is inaccessible or traffic congests in front of his door, his accessibility results in loss of sales. People who cannot reach him will seek other markets. It is that tendency which induced Sears Roebuck to build out in the Fenway.

These are some of the aspects of this problem; some of the reasons why the agencies in American cities, interested in business, have bestirred themselves

to take very definite and direct means of dealing with the problem of traffic accidents and traffic congestion.

Planning and Traffic Relief.—I should like to tell you something about the development of the technique for handling this situation and of some of the relief measures that are being used by American cities at the present time. I want to speak first briefly about city planning and regional planning in relation to traffic relief. The traffic problem is largely the problem of too great pressure; too great demand for existing facilities, therefore since the street and highway systems are inadequate the natural relief would seem to be to build additional facilities. That is a perfectly logical answer. It is limited, however, by how far a city is justified in going in spending the necessary money. Boston, for instance, has been hesitant to build the proposed so-called "intermediate highway" for passing travel around the central and southern part of the city to the North Station area. Obviously the cities are not at an end of their traffic problems. What we see today is the indication of even greater problems to come tomorrow. For the motor car, both as the carrier of people and for trucking is so useful it is evident that its use will grow. So therefore any city which fails to grasp the opportunity for traffic relief by establishing better facilities widening the existing arteries, extending its arteries, extending new streets, through construction of traffic relief measures such as the East Boston Tunnel, is, of course, missing an opportunity which, though very costly, might easily be paid for out of the losses which accrue each year. It is difficult to give an exact figure of the losses resulting from traffic congestion. I was talking with the president of the Yellow Cab Company in Chicago a year or so ago, and he said: "Don't you think too much money is being spent on traffic relief?" I said that depended on whether it was wasting as much as the money expended in relieving the situation. He said that seemed to him doubtful. I asked: "How many trips do your cabs make into the loop district?" He told me. I said: "Suppose each cab saves a minute or suppose it loses a minute; how much time would that aggregate?" So he figured out the total number of minutes involved in the operation of his 3,800 cabs, and the number of trips. I said: "How much gasoline do they use when idle?" He figured this out, and it came to 1 gal. every 40 minutes, and at the wholesale rate he was then paying we found that one minute's delay on the 3,800 cabs making trips into the center of the city had a value of something over $100,000 in one year. That indicates how much money may be involved. In Boston one could figure up a tremendous loss which any statistician would recognize as perfectly logical to be laid to the traffic problem. So a great expenditure of money may readily be justified to bring even normal or local relief.

New Principle of Street Construction.—I am not going to talk about the proposed city planning projects of Boston. I do want to emphasize, however, one particular type of relief and particular principle of plan which seem to me most critical and important at the present time in the congested portions of our cities. You realize that so long as we have the operation of vehicles on conflicting routes on the same grade we will not get great speed. If you take Commonwealth Avenue and even widen it to twice its present width Massachusetts Avenue and other crossings, such as at Cottage Farm Bridge, will always seriously limit the activity of the arterial passes to 50 or to 30 per cent of its possible capacity. If you assume two highways meeting at grade, each one with a demand for its full capacity, and then conceive of the traffic control devices necessary to take care of alternating it fifty-fifty for each road, you will see that under the most efficient conditions the capacity of each road would be reduced to 50 per cent. Actually the capacity is reduced to 35 or 30 per cent, because in starting and stopping there is additional lost motion and lost time. It becomes quite apparent in the more congested cities, such as Boston, Chicago, New York, Philadelphia and Detroit, that we must turn to a new principle of plan in street construction if we are to use the automobile to its full capacity and speed up traffic conditions.

Development of Superhighways.—Whenever a city has reached a population of approximately 1,000,000 it has been found necessary to take the traction facilities and develop rapid transit by elevated structures or by subways. You can no longer operate on the surface because of interference. The same thing is apparent in the case of the major truck lines, and rapid transit highways are being developed with grade separation so that at no point will there be the necessity of limiting the capacity of the routes through interference of cross traffic. We would have thought that idea very futuristic only a few years ago. Now we have come to regard it as inevitable. You may be interested to know that already it has passed the phase of the theoretical. It is actually being applied. Manhattan has just made an appropriation for the construction of an elevated highway along the Hudson River, with the ultimate plan of extending it all the way to Riverside Drive. Chicago has two examples of the superhighways. It is the only city I know of where one can approach within half or quarter of a mile of the business district at an average speed of forty miles an hour. This is by outer drives along Lake Michigan. They have been constructed with grade separation, without interference of any kind. So you can come into the city at forty miles an hour without the necessity of delay because of traffic control. I think that the planning feature of the future American city, so far as the trunk lines are concerned, will be the construction of elevated streets carrying traffic without grade interference and with country highway speeds. The Bureau is now conducting a study of about half Chicago's area—the Cook County area—to find out if the elevated highways going to the north and northwest would be justified. We are going about it as an engineer would go about the location of a new bridge. We are trying to find the most strategic place to locate it, etc.

But I do want to get to my particular phase of the traffic problem—the part in which the Erskine Bureau is especially interested. About seven years ago a far-sighted student of public administration saw in the city streets a problem of great importance in the future. Seven years are not a very long time, and yet when I undertook for Professor Monro research for traffic conditions, I was able to find only two articles worthy of being catalogued as serious studies of managing traffic in city streets. Today it is difficult to pick up any technical magazine without discovering something on traffic. In that short time it has come to be a very pressing and critical public problem. When we started to study it we found in American cities a situation more or less to be expected. It was a new problem and its seriousness and future importance had not been realized. It was being dealt with as a purely political problem. Officers were assigned, right and left turns prohibited, etc. The American city ordinances were a great hodge-podge of political and city regulations, as you can imagine.

Traffic Control an Engineering Problem.—The first thing we discovered was that it was not a problem to be dealt with by the agencies attempting to handle it. It was an engineering problem, capable of being studied and analyzed and solved and regulated like any other important engineering problem. So we started on that basis and attempted to erect very primitive standards and records which would justify our presenting to American cities a claim that they should establish technical agencies to deal with this problem, then of importance and which would be of much greater importance in the future. This study has now developed into a substantial system, and many American cities have begun to study traffic problems as serious engineering problems. In the last three years there have been established in fourteen American cities traffic engineering divisions. They have established agencies for studying accidents, the causes of accidents, the physical factors involved, congestion conditions, and also are following up the limitations now applied to see whether they bring the required results. Fourteen American cities have such agencies functioning in them, rendering service

similar to that given by the water engineers in connection with the water supply, and the planning engineers in connection with city planning.

A Significant Development in Traffic Engineering.—The most significant development in traffic engineering that has taken place in any American city has recently taken place under Mr. William Williams of the Department of Public Works of Massachusetts, in the creation of the Traffic Engineering Division in the commonwealth. The act of the legislature empowering the Department of Public Works to assume very wide control and jurisdiction over traffic affairs of the entire commonwealth is of significance. This is the first time that an American commonwealth has recognized officially, through its legislature, that the problem of traffic control and vehicular control by statutes and controlling devices is one that takes serious engineering attention, and is a problem to be determined and worked out on the basis of engineering ability and knowledge. It is largely through Commissioner Williams that this act was passed, and his sympathy and earnest endeavor have furthered progress in the solution of the problem in Massachusetts.

More and more city planning agencies are coming to rely upon this technique which is being developed in determining the method in which facilities should be used. Sometimes the most elaborate facilities are not warranted in order to take care of it. I have in mind the Wacker Drive situation. The construction of this drive cost $22,000,000. We watched the construction with considerable interest, and noted two or three places where the combined congestion of traffic was too great. It was designed for horse-driven vehicles. Though it was built with a double deck and wide, it does not work at all. Traffic control devices were installed and rendered it highly efficient, with the exception of two or three portions which will have to be entirely reconstructed.

The Opportunities in Traffic Engineering.—This, in brief, is the development of traffic engineering. It does present in a rather tentative and embryonic form the new opportunity for engineering skill and science offered by this traffic problem. We are depending largely on the young engineers to develop new things, and they are developing them. This is illustrated by the construction and operation of automatic traffic signals. Five years ago there were no automatic system. Today we have the choice of half a dozen signals. The city of Boston will introduce a very comprehensive system of co-ordinate signals in the near future. Only 14 cities employ traffic officers for control purposes. It will not be more than a decade, I believe, before every city of 25,000 or over will have a traffic engineer and every state highway department will be similarly equipped. And to a similar degree in the operation of large fleets of trucks there will be at their heads those capable of ordering traffic operation. This offers an opportunity to the young engineer in a new field.

Acknowledgment.—The foregoing is a paper presented Dec. 19 before the Boston Society of Civil Engineers.

"Insulated Areas" for Relieving Dangerous Traffic Conditions

An interesting arrangement for relieving dangerous traffic conditions was mentioned by E. W. James, Chief, Division of Design, U. S. Bureau of Public Roads, in a discussion on traffic control at the 1929 annual convention of the American Society of Civil Engineers. The scheme consisted essentially of an arrangement of streets within, say an area of a square mile, whereby there would be no incentive to through traffic, although there would be every means for interior communication. Only four means of exit and entrance would be available, and the streets themselves could be of narrow width, since they would handle only local traffic.

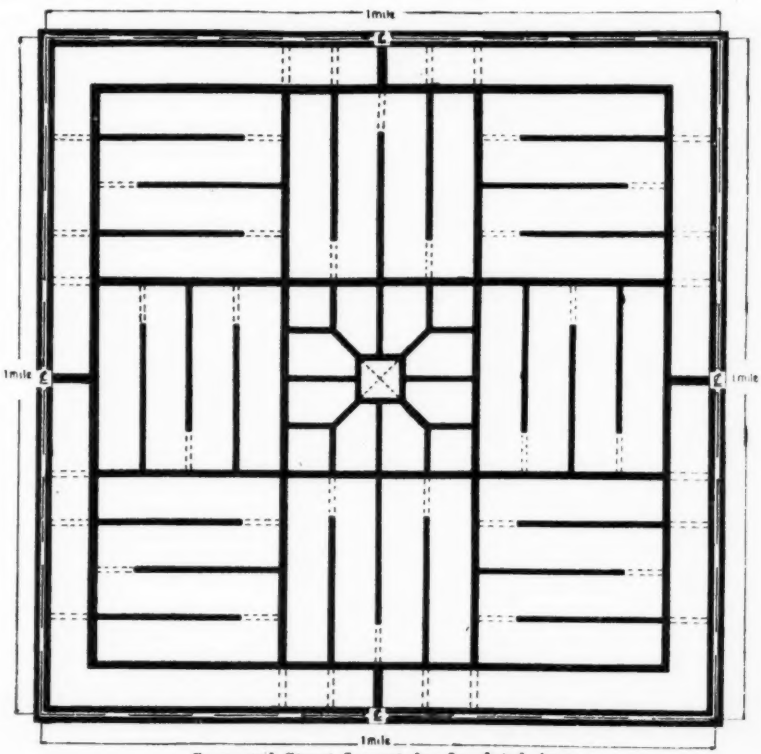
If necessary, the subdivision of such an area could be made to provide (as shown on the accompanying plan) for future extensions of through routes by cutting streets through present parks and by now providing wide rights of way for further enlargement of pavements. Mr. James estimated for such a subdivision that with "eight householders to the acre, all the traffic could leave the area on its way to work within an hour without street congestion at the exits." The interruptions by means of parks would not deter foot traffic, which could use the parkways to be provided. Such a sub-development is Radburn, near Paterson, N. J. Although the partly insulated area is only one-eighth of a square mile, it would have just about the density of population mentioned.

One particularly good feature of the idea, according to Mr. James, is its flexibility:

"Future street systems can be determined in the original layout, if it appears that the locality is likely to change usage and by a proper distribution of parks this system can be broken up and interrupted as desired so long as the area remains residential and insulated. Whenever the area is reclassified, the streets can be made continuous at no additional cost to the community for rights of way by destroying a part of the parks."

Government Statistics of the Cement Industry for February

The ratio of the operations to the capacity of the American portland cement industry during the month of February was 44.8 per cent, according to figures released March 13 by the Bureau of Mines of the Department of Commerce. During the month 8,522,000 bbl. were produced, 5,448,000 bbl. were shipped, and there were in stocks on hand at the end of the month 29,871,000 bbl. Production in February, 1929, was 3.1 per cent less, and shipments 17.0 per cent less than in February, 1928. Stocks at the mills were 9.2 per cent higher than a year ago.



Suggested Street Layout for Insulated Area

Flexible Bases for Vitrified Brick Pavements

Experiences in Mercer County, New Jersey

By HARRY F. HARRIS
County Engineer, Trenton, N. J.

SEVEN years ago the writer constructed a bituminous foundation for a short piece of brick paving. Very frankly, it was an experiment, and he could find little, if any, information to guide him in preparing his specifications as to previous practice, although it was likely that construction of this type had been attempted before.

This short paper will, therefore, be devoted to a description of the work just referred to, and a subsequent job carried out two years later, the details of which were somewhat different as to the method of constructing the base. In the first work a penetration type base was used, wherein tar was employed as a binding medium, but in the latter case the foundation was of the hot mix type of bituminous concrete. In this, asphaltic cement was utilized, to bind the mineral aggregate together, instead of tar. The first highway to be improved was located near the city of Trenton.

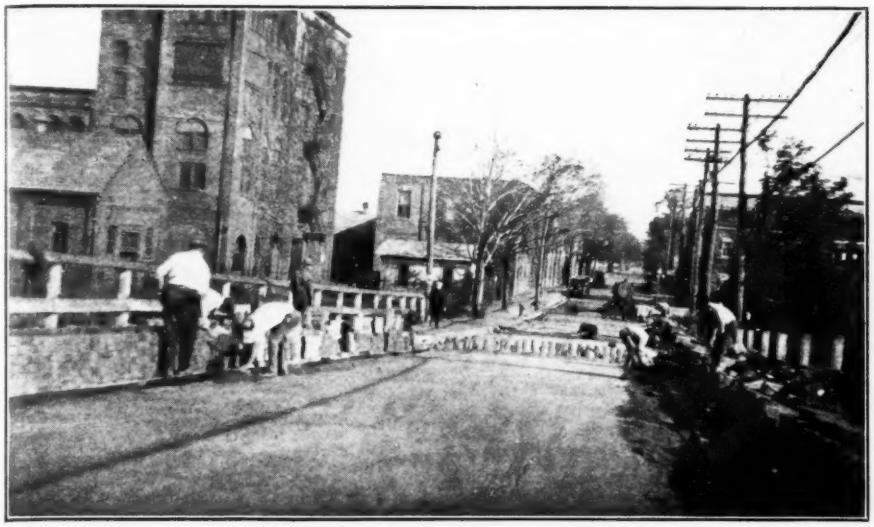
View of East Clinton Ave., Showing 5 Per Cent Grade, Paved with 3-in. Vertical Fibre Bricks, with Asphalt Film on Penetration Macadam Base

Conditions on East Clinton Ave. Job.—On both sides of the street, known as East Clinton Ave., there was located a large industrial plant which had buildings lining both sides of the thoroughfare. It was essential to keep the roadway, during the paving operation, in such condition that trucking and other vehicles would have access to the plant constantly, because large quantities of this company's product were shipped by trucks daily to a freight station, located about ½ mile distant.

Under standard methods, to improve the street for the character of traffic required, it would have been necessary to shut traffic off entirely while building the street, or construct the pavement and foundation under the half-width method, both of which methods were very undesirable, and would entail great losses to this large company, as it had no other means of access to and from the plant.

Preparation of Sub-base.—After giving some thought to the situation, it was decided that the use of a black base would solve our difficulties. As part of the street in question had a maximum grade of 5 per cent, it was decided to pave this section with 3-in. vertical fibre brick, using a bituminous filler. The old roadway was metalled with 4 to 6 in. of broken stone, about 20 ft. in width, and beneath this, for the most part, was a sandy subgrade. At the foot of the 5-per cent grade, the ground water level very nearly coincided with the proposed grade fixed for the bottom of the sub-base, and it was difficult to lower this by means of drains, except at certain seasons, because its height was controlled by the stage of a creek of considerable size, ¼ mile distant, and the material below the sub-base was filled with quick sand. The question of saturation of the subgrade and the material beneath presented some little problem. This low point in the grade was created in order to provide adequate headroom beneath the main line tracks of the Pennsylvania R. R., and the surface water from this sump was carried away by a pipe line laid at a gradient of approximately 0.001 per foot. To meet this situation,

View of Whitehead Road Near Trenton, N. J., Showing Industrial Buildings; 5 Per Cent Grade Paved with 3-in. Vertical Fibre Brick on 6-in. Bituminous Concrete Foundation



Sand Cushion Spread Ready for 3-in. Vertical Fibre Brick

a system of French drains was designed and these drains were tapped into the storm drain at close intervals, which plan, it was felt, would at least keep the base free of ground water when the stage of the creek was such as to permit the water to flow from the intake to outlet of the drain.

Our next problem was to obtain a binding medium for the penetration macadam base which would not disintegrate under the moisture to which this foundation might be subjected at certain times. After giving some thought to it, we arrived at the conclusion that tar would probably answer. Before laying our base, however, we decided to use the old macadam from the roadway as a sub-base. The subgrade was found to be very dry and sandy, as soon as we got away from the sump beneath the railroad, previously referred to. This sandy subgrade was difficult to shape and could not be rolled, so the stone sub-base, laid 4 in. thick, worked to very good advantage, because it not only reinforced our black base by adding additional depth, but it enabled the contractor to shape and roll his subgrade exactly to the contour desired for the base stone.

Construction Methods.—The foundation proper was built in two layers. The first was built 3½ in. deep, after compression, and of 2½-in. trap rock. To this was applied the hot tar by a pressure distributor, at a rate varying between 1.25 to 1.5 gal. per square yard. This was chipped with ¾-in. stone and rolled, after which the second course of trap rock, 2½ in. deep, was applied, making a total depth over all of base of 6 in. The latter course was composed of the next smaller size of stone, known as 1½-in. trap rock. This was penetrated with tar at the rate of 1¼ gal. per square yard, and chipped with ¾-in. stone to close up the voids and to facilitate the rolling. In other words, the base was composed of a penetration macadam pavement built close to accepted standard methods, except that a seal coat was omitted. Following the completion of the foundation, the remainder of the pavement was constructed as most other brick pavements are built. A sand cushion was applied to the foundation, and varied from ½ in. to 1½ in. in depth. After this was properly shaped, the bricks were laid with joints filled with asphalt filler. The contract price for the job complete was $5.39 per sq. yd., which was 11 per cent less than the engineer's estimate, and was divided as follows:

	Per Sq.Yd.
Excavation (Av. depth 1.1 ft.)	$0.49
3-in. Sub Foundation	.18
6-in. Penetration Macadam Foundation	2.05
3-in. Vertical Fibre Brick Surface	2.67
Total	$5.39

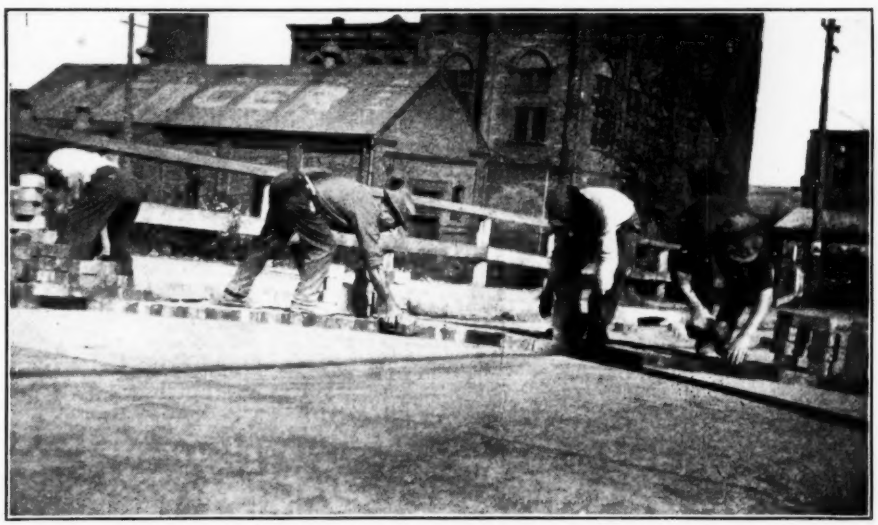
A traffic count taken over this road in 1924 showed an average daily traffic of 2,319 vehicles for a 16-hour day. In 1925 this had increased to 2,688, which is the last count taken, and it is quite probable that the present traffic exceeds 3,000 vehicles per day, a comparatively large part of which is composed of commercial cars.

During the building of this street, traffic was maintained throughout every working day, although there were certain periods during some of the days, where the manufacturer had to delay his hauling a matter of a few hours, which is almost negligible, when compared to what the delays and loss would have been, had some other method of construction been selected.

The Whitehead Road Improvement.—Two years later the engineering department of the county was faced with a similar condition in a nearby district. This highway, known as Whitehead Road, also passed through an industrial section, where no detours were available, and it was necessary to maintain traffic. As the experiment had worked out rather satisfactorily in the previous case, it was decided to resort to much the same methods as used before. The drainage conditions were better, however, and it was believed that if a hot mix asphalt was used for the base, instead of a penetration macadam, it could be laid quicker and to a truer surface, as some little difficulty was experienced in the former job in getting a true contour. The foundation was laid in two 3-in courses, each of which was rolled and compacted in the usual way of laying ordinary bituminous concrete pavement. It was specified that the weight should not be less than 600 lb. per square yard of completed base. When completed, it was found that it had been laid at the rate of 655 lb. The stone composing this base was of somewhat smaller size than the original job.

The Black Base.—A typical analysis of the black base mixture follows:

Screens and Sieves — Passing	Retained On	Percentage
1½ in.	1 in.	20.8
1 in.	½ in.	45.0
½ in.	¼ in.	8.0
¼ in.	10 Mesh	2.6
	Stone	76.4



Laying Brick on Whitehead Road, Mercer County, New Jersey

10 Mesh	30 Mesh	4.0
30 Mesh	50 Mesh	4.2
50 Mesh	80 Mesh	4.6
80 Mesh	200 Mesh	4.4
200 Mesh		1.6
	Sand	18.8
Bitumen Content		4.8
	Total	100.0

This mixture was manufactured in a regular asphalt paving plant, located about a mile away and hauled to the job. The asphalt cement used had a penetration of between 40 and 45. It was found that the hot mixed pavement rolled to much better advantage than the penetration foundation, and it was laid for 5 ct. less per square yard than the penetration foundation, but for some unknown reason the price of brick surface was increased over the price obtained two years previous by 68 ct. per square yard. It may be, however, that the first contractor lost money on his brick surface.

Spreading Sand Cushion Over Flexible Base on Whitehead Road

Costs.—The total cost of the second job was $5.82 per sq. yd., or 7 per cent in excess of the engineer's estimate, and 43 ct. over the price obtained two years before. This price was divided as follows, on a square yard basis:

	Per Sq. Yd.
Excavation (Av. depth of 7 in.)	$0.20
4-in. Stone Sub Foundation	.27
6-in. Bituminous Concrete Foundation	2.00
3-in. Vertical Fibre Brick Surface	3.35
Total	$5.82

It should be remarked that these jobs have required no maintenance expenditures whatever, except for the repairing of a slight settlement which occured over one of the French drains in the first described job.

As a result of the experience of these two contracts, a total of 40,000 additional yards of pavement with black base was subsequently utilized, using other types of surfacing, and as an expedient for meeting difficult traffic situations with a minimum of delay in construction, it is believed that the use of black base is a big step in solving this difficulty.

In conclusion, the writer wishes to make it clear that he does not claim that the form of construction described offers a panacea for all our difficulties encountered in road design and construction, but like many other problems which all engineers meet in their practice, the remedy selected for a given ill must be adaptable to the peculiarities of the case in question, after all the factors concerned have been given proper consideration.

Acknowledgment.—The foregoing is an abstract of a paper presented Feb. 15 at the 23rd annual meeting of the National Paving Brick Manufacturers' Association.

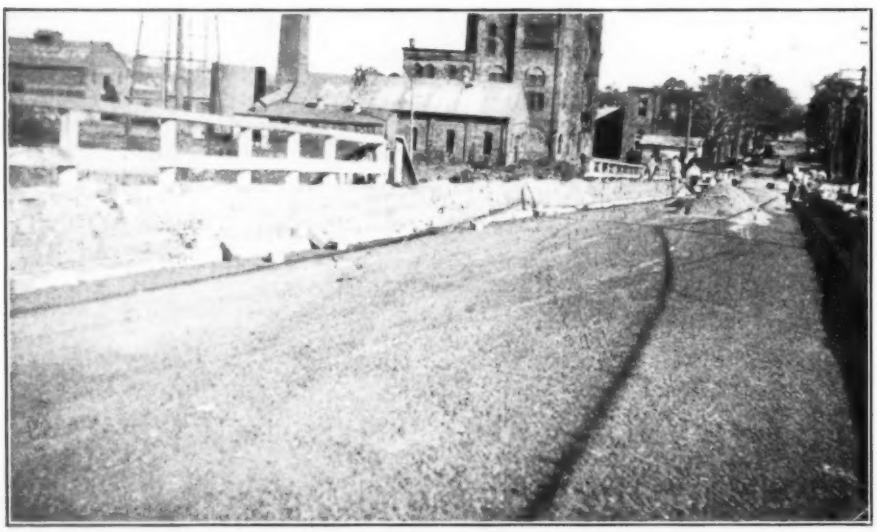
Cleaning Well Screen with Steam

Various well water supplies in Maryland have on different occasions experienced trouble with the clogging of well screens. A study was made by the Bureau of Sanitary Engineering of the Maryland State Department on the well screens from Princess Anne to find a satisfactory method for cleaning. The results are summarized as follows in the 1928 report of Abel Wolman, Chief Engineer of the bureau:

The deposits on the inside of the screens consisted principally of iron oxide and had accumulated to such an extent as to coat almost completely over the openings, thus preventing any water from passing through the brass mesh. An attempt was made to clean the screens with (1) dilute hydrochloric acid; (2) dilute nitric acid; (3) compressed air (100 lb. per sq. in.), and (4) steam (140 lb. per sq. in.).

Both hydrochloric and nitric acid removed the deposits fairly readily, but the acids attacked the screens to such an extent that the metal was destroyed rapidly. The deposits when dry were removed rapidly and completely from the screen by compressed air, but the process is very dusty and would be inconvenient in practice. In addition, high pressure air is not available at most plants.

Steam readily cleaned the deposited iron oxide from metal and is not objectionable from the standpoint of dust formation. An inspection of the screens after steaming showed that the process was effective and almost completely removed the deposits. The method of operation consisted merely in discharging the steam through a ½-in. jet against the outside wall of the screen and then passing water through the screen to wash out of the small amount of oxide that has not been blown from the inside of the screen tube. A single screen section could be cleaned by this method in five minutes, and with a steam supply available, the cost of treatment is practically negligible.



Whitehead Road Flexible Base Ready for Sand Cushion

The Dunbar Sewage Filter Bed

Investigations at Texas Engineering Experiment Station

THE Dunbar sewage filter bed was developed in Germany by Dr. Dunbar, who built a number of installations at Hamburg and elsewhere which apparently did good work. Several beds following the Dunbar model were built in Texas during the past ten years. Inspections of the Texas plants usually revealed that, even with all the vicissitudes of operation which the small city plant must usually withstand, the effluent was fairly clear and inodorous, caused no unpleasant conditions in streams and the plants, in general, were free from nuisances. The plants, from this standpoint, appeared to have some advantage over the ordinary trickling filter.

Examination of sewage treatment literature discloses the fact that little or no study has been made of the Dunbar bed, as to its effectiveness in treating sewage, its method of operation, or its particular field of application. Accordingly, an experimental filter bed was constructed at the A. and M. College of Texas and tests of the effluent, under varying conditions of operation, were made by the Sewage Research Division of the Texas Engineering Experiment Station. The results of the investigation have been given in a bulletin issued recently by the Texas engineering experiment station, of which F. E. Giescke is director. The bulletin was writen by E. W. Steel and P. J. A. Zeller, and from it the matter in this article has been taken.

Construction of Experimental Bed.—The details of construction of the experimental bed are shown in Fig. 1. They follow, in the main, those developed by Dr. Dunbar. A 16-in. layer of comparatively fine material was supported by several layers of graded aggregate and the whole rested upon a layer of rather large material.

Sizes and thicknesses of layers beginning at the top were as follows:

16 in. layer	1/25	in. to	⅛ in.
4 in. layer	⅛	in. to	⅜ in.
4 in. layer	⅜	in. to	1½ in.
24 in. layer	3	in. to	6 in.

The bed was 4 ft. wide, 6 ft. long, and 4 ft. deep. The bottom and sides of the filter bed were constructed of wood with holes bored in the sides near the bottom, so that air might enter the lowest layer of filtering material. The bottom of the box was lined with sheet metal. An opening with a small trough at one end drained the bed, and allowed collection of samples.

In order to obtain variable rates of application of sewage to the bed, an orifice in a metal tank was used. The head on the orifice was varied by regulating the height of an overflow pipe which discharged excess sewage from the dosing tank. The orifice discharged upon a flat tile to prevent scouring the surface of the bed. The bed was located at the east side disposal plant of the A. & M. College and so placed that it received, by gravity, sewage settled in an Imhoff tank. Except for occasional clogging of the orifice during the first few runs of the bed, no difficulty was experienced in obtaining the rates desired.

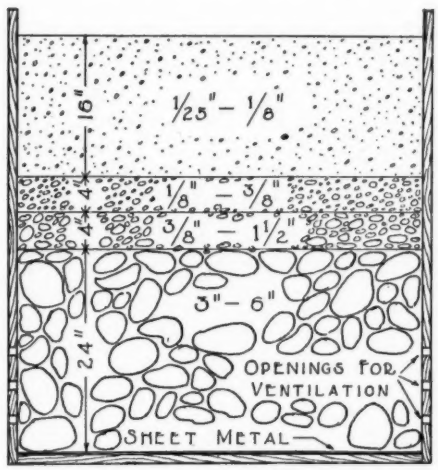


Fig. 1—Cross Section of Experimental Dunbar Filter Bed

Operation of Experimental Bed.—Dunbar beds are dosed by means of a trough running down the middle of the bed. The sewage leaves the trough through holes or by overflow, and percolates into the filtering material. The dosing continues until the surface of the bed is clogged, which is indicated by the sewage standing several inches deep over the bed. The bed is then thrown out of operation for rest and for cleaning of the surface.

The procedure just described was followed in the experimental work. The sewage was applied to one end of the bed directly from the orifice and allowed to spread over the surface until clogging caused the sewage to stand at a depth of 3 to 4 in.

Since the purpose of the study was to determine the efficiency of the Dunbar bed under various dosages, and to discover the most favorable rate of dosage, the experimental bed was operated at widely varying rates. Tests were made of the applied sewage and the effluent to determine the effects of varying conditions upon the bio-chemical oxygen demand, suspended matter, dissolved oxygen, free ammonia, nitrites, and nitrates. The tests extended over a period of one year, during which time the bed was operated as nearly continuously as the necessary resting and drying periods permitted. The sewage treated was stronger than the average domestic sewage which has been settled in Imhoff tanks.

Findings.—As might be expected, the quality of the effluent varied with the rate of dosing and to a lesser extent with the character of the applied sewage. Aside from these factors, no other conditions appeared to have any appreciable effect. Temperature conditions are favorable in this section of Texas and the few periods of low temperature made no apparent difference in the action of the bed. There was no pronounced falling off in the quality of the effluent during the progress of a run. That is, the bed worked as effectively after operating three or four days as it did immediately after resting.

During the investigation it soon became apparent that the practical rates of application lay between 1,000,000 and 2,000,000 gal. per acre per day. It finally appeared that 1,300,000 gal. was most suitable.

Bio-Chemical Oxygen Demand.—These determinations were made by the dilution method, using Mohlman's diluting water (i. e., distilled water containing 500 ppm. of sodium bicarbonate), and incubating for 5 days at 20 degrees Centigrade. Theriault's differential method of calculation was used in arriving at the demand.

The reduction in the oxygen demand was uniformly good, averaging 85 per cent. A very few tests showed 75 per cent, while others indicated over 90 per cent reduction. The reduction was practically independent of the rate of dosage and of the strength of the applied sewage.

The applied sewage varied from below 100 ppm. to as high as 400 ppm. in bio-chemical oxygen demand. The

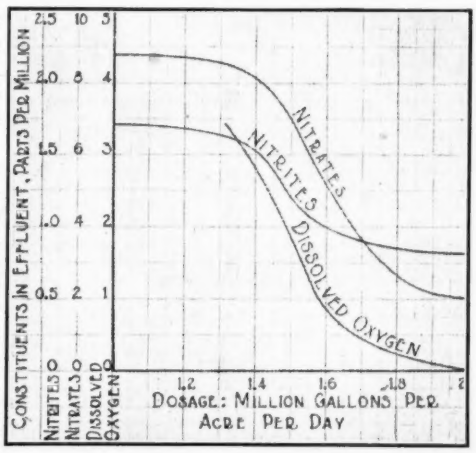


Fig. 2—Curves Showing Relation Between Rate of Dosing and Nitrites, Nitrates, and Dissolved Oxygen

Table I—Data Obtained in Three Typical Runs of the Bed

			INFLUENT					EFFLUENT						CHANGE				
			Solids ppm					Solids ppm										
No. of run	Rate Million gals. per acre per day	Days	Total	Suspended	B O D ppm	Ammonia ppm	Nitrates ppm	Total	Suspended	Dissolved oxygen, ppm	B O D ppm	Ammonia, ppm	Nitrites ppm	Nitrates ppm	B O D Reduction percent	Suspended Solids Reduction percent	Ammonia Reduction percent	Nitrite Increase ppm	Nitrate Increase ppm
20	1.32	0	2060	52	145	22	0.24	2100	6.6	4.2	16	1.8	5.6	9.0	89.0	87.3	91.8	5.6	8.8
		1		44	107	17	0.40		6.8	4.4	11	2.0	1.2	3.0	89.5	84.6	88.2	1.2	2.6
		2	2010	41	116	12	0.00	1910	8.4	4.0	10	1.0	1.5	8.0	91.2	79.3	91.7	1.5	8.0
		4	1773	25	95	18	0.60	1720	6.8	2.9	12	3.8		4.4	87.5	72.8	79.2		3.8
		5	1855	28	88	18	0.95	1800	6.2	3.3	16	1.0		3.2	91.7	77.9	94.9		2.2
		Average	1924	38	111	17	0.44	1882	6.96	3.76	13	1.9	2.8	5.52	88.0	81.6	89.0	2.77	5.08
28	1.64	1	2180	99	219	26	0.48	1750	47	1.9	25	3.6	1.5	3.0	88.5	52.2	86.2	1.5	2.5
		2	2670	58	95	23	0.16	2030		0.7	26	1.6	.45	1.4	72.8		93.5	.45	1.2
		3	1990		185	18	0.16	2315	39	0.2	31	1.4	.45	0.4	83.5		92.2	.45	0.24
		4	2135	92	252	36	0.56	1865	39	0.1	46	1.6	.30	0.5	81.8	57.3	95.5	.30	—.04
		Average	2244	83	188	26	0.34	1990	41.7	0.73	32	2.0	.68	1.33	83.0	49.8	92.1	.68	0.99
24	1.97	0	2035	15	221	14	0.6	2710	18	0	37	1.6	1.5	2.2	83.3	+12.4	88.6	1.5	1.6
		1	1880	61	177	22	0.2	2005	14	0	15	1.0	1.5	4.8	91.7	77.7	95.4	1.5	4.6
		2	1845	93	226	18	0.16	2665	20	0	28	1.0	.75	0.7	87.6	78.5	93.7	0.75	0.54
		3	2125	97	147	22	0.0	2780	22	0	33	1.4	1.4	1.2	77.7	77.1	93.6	1.4	1.2
		4	2090	108	217	22	0.0	1750	21	0	25	2.0		1.4	88.7	78.2	90.9		1.4
		5		25	102				10	0	21				79.4				
		Average	2007	66.5	182	19	0.19	2382	17.5	0	26	1.4	1.29	2.1	85.5	73.7	92.7	1.29	1.91

amount of actual reduction varied, but the percentage reduction was practically constant. Doubling the rate of application of the sewage to the bed, that is, from 1,000,000 to 2,000,000 gal. per acre per day, produced only minor fluctuations in the percentage reduction.

The relative stability of the effluent was not determined as a routine test. A number of tests were made, however, and in nearly all cases complete stability was obtained.

The ability to reduce the oxygen demand to such a high degree under varying circumstances is an important quality of the bed as it insures good treatment of the sewage, even though the bed be overloaded, poorly operated, or the settling tanks operated inefficiently.

Nitrogen.—The reduction of free ammonia was uniformly high. Here, also, the quality of the applied sewage had no appreciable effect. High rates of application, also, lessened the percentage reduction only slightly.

Varying the rate of application had its principal effect upon the production of nitrites and nitrates. Variation in the quality of the effluent with the rate of dosage is shown in Fig. 2. For example, for a rate of 1,000,000 gal. per acre per day the effluent contained 10 ppm. nitrates, 2 ppm. nitrites, and 4 ppm. dissolved oxygen. Increasing the rate of dosage caused a decrease in all three quantities, gradually at first, but quite rapidly at 1.6 millions. Table I shows some of the data from which Fig. 2 was constructed. As might be supposed, the high rates interfered with complete nitrification. With favorable rates of application, however, an ammonia reduction of 90 per cent may be expected, with nitrites in the effluent amounting to 2 to 3 ppm., and nitrates from 5 to 10 ppm. High rates of dosage caused a very considerable drop in the nitrates with a tendency for them to hover around 1 to 2 ppm., and with the nitrites somewhat less in amount.

With the ammonia reduction remaining practically constant with varying rates of dosage, and with the nitrates and nitrites considerably less with high rates of dosage, the question arises as to the cause of the discrepancy between the ammonia nitrogen and the total of the nitrite and nitrate nitrogen. Even with the lower rates of dosage, similar discrepancies occurred, the ammonia reduction indicating a higher nitrification than was actually taking place. There may be several explanations. The nitrogen may combine with organic matter. Or, especially with the high rates of filtration, denitrification may be taking place through the agency of denitrifying bacteria. The services of a bacteriologist were not available to investigate the cause of the variations.

Dissolved Oxygen.—Fish require dissolved oxygen. The maintenance of fish life near a disposal plant outlet materially reduces mosquito nuisances. Accomplishing this has been particularly difficult in Texas, where many of the streams receiving plant effluents furnish no diluting water during the summer months. Consequently, dissolved oxygen determinations were made to discover the maximum rate of dosage at which dissolved oxygen might be expected in the effluent. Effluents containing dissolved oxygen in appreciable amounts will probably be well nitrified and stable.

With a rate of more than 1,600,000 gal. per acre per day no dissolved oxygen appeared in the effluent at any time. (See Fig. 2.) As the rate was decreased the dissolved oxygen rose rapidly, reaching 4.0 ppm. in many samples when the rate of dosage was 1,000,000 gal. per acre per day. Operating at the rate of 1,300,000 gal. per acre per day should assure enough oxygen to support the top-water minnow. Fluctuations in strength of the influent, as measured by the bio-chemical oxygen demand, showed no appreciable difference in the dissolved oxygen content of the effluent.

Suspended Matter.—Removal of suspended solids showed considerable variation under different conditions. Percentage removals tended to be greater when the suspended solids in the influent were high. The nature of the suspended matter was an important factor. When it was coarse and flocculent, removal was high; when the solids were colloidal, reduction was smaller. Varying the rate of dosage caused a variation in percentage removal, but its effect was less than that of the variation of the quantity and the condition of the suspended matter. The average removal, arrived at by considering all the runs of the bed, was about 75 per cent. In every case, the effluent from the bed was colorless and clear, in spite of the fact that the color and turbidity of the influent were frequently quite marked.

Dosage.—From the data obtained, it appears that 1,300,000 gal. per acre per day is the optimum rate. Lower rates add little to the quality of the effluent. Higher rates produce an effluent less nitrified and with little or no dissolved oxygen. (See Fig. 2.) From the standpoint of economy, therefore, it would be inadvisable to dose at rates lower than the optimum. Higher rates, however, might be permissible where some diluting water is available at all times in the stream receiving the effluent.

Low and high rates of dosage exert a considerable influence upon the length of runs before cleaning of the filter surface becomes necessary. Length of runs varied not only with the rate of application, but also with the amount and character of the suspended matter in the applied sewage. The actual volume of suspended material removed varied with each run. The conclusion reached was that the quantity of suspended matter and its physical condition have an important bearing upon the operation of the filter bed. Upon an average, the bed handled a total of 8,000,000 gal. per acre before clogging was severe enough to necessitate resting and cleaning.

Length of rest period apparently had but little effect. The rest periods were long enough to allow the surface clogging material to dry. This required less than 36 hours under average conditions, provided there was no rain. prolonging of the rest period beyond the 36 hours had no effect, beneficial or otherwise, upon the effluent produced during the next run. Cleaning of the surface preliminary to resuming operation proved to be necessary. When it was omitted, clogging occurred within 24 hours after the bed had again been placed in operation.

Cleaning Bed Surface.—The solids strained out and retained on the surface of the bed dried, in good weather, within 36 hours. They were then in the form of curled, leathery, black flakes, ¼ in. or less in thickness, more

or less detached from the bed surface, and they could easily be raked or hoed into piles and then removed. The work of cleaning a bed of practical size, say 30 ft. by 70 ft., will consume only an hour or two of an operator's time and will produce only a few wheelbarrow loads of dried solids. There is no appreciable loss of filtering material in removing the solids.

Summary and Conclusions.—The experimental work has established the following outstanding characteristics of the Dunbar filter:

1. At rates of operation up to 2,000,000 gal. per acre per day, an 85 per cent reduction in the bio-chemical oxygen demand may be expected.
2. Operation at the rate of 1,300,000 gal. per acre per day proved to be the optimum rate. It is the highest rate at which the following condition can be secured:
   (a) Good nitrification of the effluent.
   (b) High dissolved oxygen in the effluent.
3. Operation at a rate above the optimum and up to 2,000,000 gal. per acre per day will produce a clear effluent, satisfactory for many purposes, but nitrification will be incomplete and dissolved oxygen will not be present.
4. Clogging of the bed may be expected after the application of 8,000,000 gal. of settled sewage per acre of bed surface.
5. Prolonged resting of the bed between doses is unnecessary, although it apparently does no harm. Resting is necessary only to allow drying and removal of the solids caught upon the surface of the bed.

Chlorination of Deep Well Supply

Elimination of Iron Bacteria from Distribution System

By M. F. TRICE

Assistant Engineer, State Board of Health, Raleigh, N. C.

In the early summer of 1928 a disagreeable taste and odor developed in the Siler City water supply. At that time the municipal water system had been in operation three years. There had been no objection to the city water during the first year, but during the second, in the spring of 1927, a taste and slight odor developed which was easily detected. This condition existed for some two months, disappearing before the end of the summer; the one remedy applied at the time was periodic flushing of the mains. No trouble has been experienced during the winter months. With the advent of spring, however, the taste and odor returned with greater intensity, reaching a maximum last May. The citizens refused to use the city water preferring well and spring supplies. Flushing of mains was resorted to, but with little success. Samples of water sent into the State Laboratory for examination were found to be of satisfactory sanitary quality. This fact was broadcast, but to no avail, and complaints were daily piling into the city clerk's office. This was the status of the problem when an investigation was begun to locate and, if possible, to eliminate the offending taste and odor.

General Features of Water System.—The present municipal supply was constructed and installed during the summer of 1925 and was put into service in September of that year. Briefly the system consists of two deep wells, 365 and 380 ft. deep, respectively. A separate pump serves each and both discharge into a covered concrete reservoir of 200,000 gal. capacity. As an additional reserve a steel elevated tank of 100,000 gal. capacity is available. All equipment, mains, service connections, etc., were new except one pump bought second hand.

The fact that entire system was of new material made pipe growths appear an unlikely hypothesis. Contamination from an open trap door in reservoir or elevated tank or possible diffusion of mill sprinkler water into the city mains received more serious consideration as an explanation. Investigation disclosed that the trap doors to the reservoir and elevated tank, respectively, were always closed.

A textile mill, operating a sprinkler system using city water, was connected through check valves and several other industrial establishments using air filled sprinkler systems were found to maintain a constant air pressure greater than the water pressure. The air systems, too, were connected to the city system through a complicated arrangement of valves. The various mill sprinkler systems have been installed since the town supply was inaugurated, except the textile mill whose sprinkler system antedates the establishment of the town supply. Some doubt existed as to whether or not the latter should be eliminated as the source of trouble. It was eliminated for the time being as were the other industrial establishments and attention directed to the mineral and biological character of the water.

Iron Content of Water.—Ground water supplies of the state differ from the surface supplies in that practically all are hard waters and contain an appreciable and sometimes objectionable quantity of iron. The Siler City water was characteristic of all such supplies, the iron content being noticeable as indicated by housewives complaining of a brown sediment forming in kettles and pots. Field equipment did not contain reagents for an iron determination. Results of a few simple tests are as follows: pH 7.2; hardness (soap method) 81 p.p.m. and alkalinity to methyl orange 103 p.p.m.

It was observed on several occasions that in flushing mains the water flowing for the first few minutes contained a brown sediment. Every water superintendent is familiar with such occurrences and expect such to happen in sections of town where little water is used. It is often the case that water acquires a flat taste and sometimes an odor due to stagnation in a pipe line that serves few houses. This condition is immediately relieved by a thorough flushing of the mains. A great many taste and odor problems are relieved by this simple expedient. At Siler City the taste and odor persisted in spite of thorough and frequent flushings. Evidently then some pipe condition was to blame.

Samples of water from the hydrants containing this brown sediment were therefore examined microscopically for the presence of iron bacteria, as crenothrix was suspected. In several samples examined small thread-like filaments were observed. This seemed to be sufficiently conclusive that iron bacteria existed in the distribution system. As flushing had not removed the taste and odor problem, it was decided to sterilize the mains with chlorine.

Application of Chlorine. — Accordingly, an emergency chlorinator outfit was brought from Raleigh and a tank of chlorine obtained. As a heavy application of chlorine seemed advisable, it was deemed unwise to chlorinate during the day. Therefore, to inconvenience the citizens as little as possible, the chlorination was begun at eleven o'clock at night.

The chlorinator is a dry feed apparatus of the diffuser type. It was attached to the effluent from the reservoir at a point half way between that and the pump to town. With a hydrant open in town, pumping was started with strong chlorine application. A hydrant was allowed to run until a good orthotolidine test was obtained, when another hydrant was opened and the process repeated. Thus hydrants were flushed in all parts of town until the entire system was saturated with chlorine. This required about five hours, as chlorination was complete at 4:00 a. m. the following morning.

The next day the town office received many complaints, as the chlorine content of the water was sufficient to be objectionable. With the disappearance of the chlorine from the system, the taste and odor situation improved and within a week all trace of it was gone. The superintendent is positive that flushing alone would not have completely remedied the trouble, and provided that it would have been effective, the cost would have been much greater.

This is the first instance of its kind in North Carolina where iron bacteria have been satisfactorily eliminated from a distribution system with chlorine.

Acknowledgment.—The foregoing is a paper presented before the North Carolina Section of the American Water Works Association.

Sewage Treatment Plant Records at Worcester, Mass.

Careful Preparation of Records May Save Expensive Litigation

By ROY S. LAMPHEAR
Supervising Chemist, Sewer Department, Worcester, Mass.

SEWAGE treatment was first started in 1890 by the city of Worcester under an act of legislature. During the life of the old plant, the attention of the court was directed from time to time to the condition of the Blackstone River below the discharge of the Worcester plant effluent. No court action proceded very far before it was dropped. Laboratory records maintained in great detail have always been considered an effectual barrier to such court action. The city of Worcester has from time to time carried on a considerable amount of experimental plant operation. For more than 20 years operators have signed tags accompanying daily composite samples and these tags have been carefully filed upon advice of the city solicitor.

The present sewage treatment plant was placed in operation in June, 1925, in accordance with an act of legislature. The state department of public health has certain jurisdiction over the plant in case of inefficient operation. In case of action against the city of Worcester involving the sewage treatment plant, the operating records and the chemical analyses of the plant and river samples furnish the real defense or protection. The writer has perhaps gone further into this matter than seems necessary because he feels that the expenditure of a small sum of money in careful preparation and preservation of records may save expensive litigation, if ever such occasion should arise.

Record of Daily Operation.—A daily operation record form, as shown in Fig. 1, is filled out by the foreman who records all of his observations of unusual conditions in the work done. In a general way, the form is self-explanatory; blank columns are left for additional time charges, the four usual charges having been noted. The dosing tank counter readings are those at 7 a. m. of the next day, so that the Venturi meter and counters can be checked against each other when no sewage or Imhoff tank effluent has been by-passed. The operators use a notebook in which to record the meter and counter readings. When by-passing of sewage or Imhoff tank effluent occurs, the chemist has the data for determination of the quantity by-passed.

The foreman is required to record all routine operations and any measurements relating thereto, such as grit in chambers before and after flushing, depths of sludge and scum in the Imhoff tanks. If the cost of some particular work is desired, the blank time columns are used. The chemist makes any notations desired on these sheets from day to day.

These daily operation sheets are held in a loose-leaf cover for periods of four months and then bound in press-board for keeping as original records. Data from them are recorded each day in ink in a daily operation record and a sludge disposal record. Ready reference in detail is quickly available; nothing is entirely dependent upon memory and, in case of necessity, the records and daily operation sheets become valuable evidence in court.

A check upon the time of cleaning the screen is available, as the Venturi meter charts show the increased rate of sewage flow. A Ferguson rain gage and a snow-board furnish the rainfall and snow records. A Bristol recording thermometer registers the temperature of the air throughout the seven days of the week. These charts are carefully filed for reference. Signatures of operators and helpers are required on the same tags, which are carefully preserved by direction of the city solicitor.

Records of River Below Point of

Sewage Treatment Plant
Worcester, Mass.
Daily Operation Record

Day ____ Date ____

No.	S.	I.	F.	S.
121				
8				
10				
25				
26				
44				
57				
109				
117				
127				
130				
141				
149				
214				
219				
281				

Temperature Air °F. Max. ____ Min. ____
Meter Reading 7 A.M. ____
Next Day 7 A.M. ____
Sewage Flow— Gallons ____

Shift No.	1	2	3	Total
Screenings Cu. Ft.				
Skimmings Cu. Ft.				
Fine Screenings Cu. Ft.				
Scum Cu. Ft.				
Nozzles Cleaned				

Sewage By Pass Open From ____ To ____
From ____ To ____
I.T.E. By Pass Open From ____ To ____
From ____ To ____

D. T. Counters

Tank	A.	B.	C.	D.
North				
South				

Sludge Disposal

Bed No.			Team	Cart	Scr.	H-B.
Loads						
Cu. Yds.						
Gas Gals.						
B-G						

Sludge Pumping				Out of Service					
Tank	In	Sampler	Bed	I.	F.	S.	From	To	Cause

Foreman

Fig. 1—Form for Recording Daily Operation of Sewage Treatment Plant of Worcester, Mass.

Second Shift 3 P.M. to 11 P.M.

Weather

Operating Notes

Operator

Third Shift 11 P.M. to 7 A.M.

Weather

Operating Notes

Operator

Back of Fig. 1

Effluent Discharge.—Samples of Blackstone River water are collected once a week. The collector signs dated tags and fills out a record of observations, a copy of which is shown in Fig. 2. The tags are filed; the loose-leaf observation records are held in a cover for one year and then bound in press-board covers and properly labeled. The analyses of the river water are recorded on a printed form at the laboratory bench and transferred to the laboratory record. The laboratory forms are bound in press-board once a year.

BLACKSTONE RIVER - Inspection and Sampling

Date	*Weather*		*Temp. Air*	
	Am. Steel & W. Co. Pond	*Millbury St. Bridge*	*Greenwood St. Bridge*	*Riverlin St. Bridge*
Time - Temp.				
Height Water				
Current - Rate				
Wind				
Odor - Air				
Color				
Turbidity				
Surface Water				
Light Oil				
Black Oil				
Foam				
Gassing				
Exposed Flats				

Observer

Fig. 2—Form for Report on Inspection and Sampling of Blackstone River

Laboratory Records.—Laboratory bench work on plant samples is recorded in common blank books which are lettered and indexed and, when filled, are filed as original records. Routine data are recorded in the laboratory record or the laboratory daily record from day to day. Comparisons are easily made and the original records are available if desired. Four laboratory books are in use so as to prevent any delay of the work.

In addition to the laboratory record and the laboratory daily record, the supervising chemist uses two 5½ by 8½ in. note books of excellent quality, one of which contains the summary of laboratory work which does not pertain to plant operation, while the other contains results and summaries of all experimental work in the laboratory connected with plant operation as well as experimental plant operation data. In a way of research, the latter notebook is the most valuable record that is obtained.

Such completeness in the matter of records of laboratory work has been the pride of the Worcester plant for a great many years. There is only one essential record missing in connection with operation of present plant. This is a gage-house located on a prepared section of the Blackstone River channel, with apparatus for transferring river water elevations to a chart record located in the laboratory office. In the early days of old plant operation, a section of the river channel was boarded, bottom and side-walls, and charts used with a float in a well at the river bank. In later years, the boards rotted away and flood flows exceeding the height of the sidewalls covered acres of land so that accurate records were impossible.

Mr. Andrew B. Holmstrom is superintendent of sewers and the writer is in charge of the sewage treatment plant.

Regional Government in Ohio

A bill has been introduced in the Ohio legislature carrying with it a constitutional amendment providing for regional plans of government in Ohio. The constitutional amendment, in brief, permits: (1) the legislature to establish alternative forms of county government; (2) one of these forms to be an incorporated county, in which the county government would have power to control the water and sewer system, rapid transit, health and other broad powers; (3) such a county to adopt a charter only if a majority of the voters in the suburbs approve it, and also a majority of the suburbs themselves, in addition to a majority in the City of Cleveland.

Significance and Methods for Determination of Filter Plant Turbidities

Various Devices and Instruments and How They Are Used

By JOHN R. BAYLIS
Physical Chemist, Bureau of Enginering, City of Chicago, Ill.

TURBIDITY may be defined as solid particles suspended in solution, and to be more specific, particles in which none or only a part of the light will shine through. Just how small the particles may be and still be in the solid state is not known definitely, but it is evident they may be so small they do not settle rapidly from water. To distinguish between the coarser and the finer particles the term "colloidal matter" is frequently applied to the finer particles. There may be considerable difference between what the water chemist calls colloidal matter and the classification that would be given the turbidity by the physical chemist. The water chemist means suspended matter that is so finely divided it does not settle rapidly.

The suspended matter almost invariably has a specific gravity considerably greater than that of water, and it seems evident there must be some factor tending to neutralize the action of gravity. An English botanist, R. Brown, discovered in 1928 that small particles suspended in solutions were in a constant state of motion*. This is called the brownian movement. I do not know that Brown offered an explanation as to the cause of this movement, but it is now conceded to be caused from a bombardment of the particles by the molecules or electrons of the solution that are in a state of rapid motion. It is believed that this is largely responsible for the slow settling of the fine particles, especially those known to have a specific gravity much greater than that of water.

Sizes of Particles.—Crystalline particles 5 micra (Micra is the plural for micron. One micron is 0.001 mm.) in diameter or larger will settle fairly rapidly when suspended in water, and if we were concerned with particles this size or larger there would not be much need for filtration to clarify water, for it would likely be cheaper to settle the suspended matter in reservoirs. It is possible to make a suspension that probably will never settle, India ink being a good illustration. Some years ago the writer kept a bottle of water that originally had a turbidity of 5,000 standing without agitation for 5 years and it still had a turbidity of 15 to 20. This, however, is the exception and not the general rule, for most turbid waters will become fairly clear when allowed to stand in bottles for a few weeks.

*Brown, R., Phil. Mag., 4, 161. (From Bancroft's Colloidal Chemistry.)

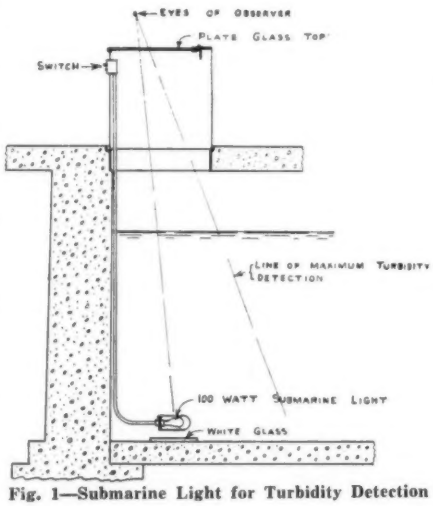


Fig. 1—Submarine Light for Turbidity Detection

It is believed that very few particles of solid matter below 0.1 micron in diameter occur in most surface waters. It is really the particles between the size of 0.1 micron and 2 micra that concern us most. This happens to be about the size of most of the bacteria that occur in water. Should a particle 3 or 4 micra in diameter happen not to become entrapped in the coagulation of chemically treated water it likely would be filtered out, but a particle 1 micron in diameter or less not entrapped has a fairly good chance to pass through the filter. Now if this particle happens to be a bacterium it also has a very good chance to pass the filter.

It cannot be stated that bacteria are removed in direct proportion to the turbidity removed by filtration, for it is known that they are not, but it is in the same direction. If the turbidity of the raw water was 100 and the number of bacteria were 1,000 per cc., reducing the turbidity 99 per cent probably would not reduce the bacteria more than 90 per cent, whereas reducing the turbidity 99.9 per cent may reduce the bacteria 99 per cent. It is evident that the actual results may vary greatly from these figures for different waters, yet they are not so greatly in error for average results. They are given more to illustrate the point than to state actual efficiencies that may be expected.

Turbidity Removal as Index.—Turbidity removal may be used as an approximate index of bacterial removal, and while not very accurate it has the advantage that it can be determined immediately whereas it is necessary to wait 24 hours for bacterial counts and 4 to 5 days for B. coli determinations. It is necessary to know something about how the bacteria usually run in the water to predict the bacteria that may be expected from the clarity of the filtered water, but after one or two years' operation of a filter plant where accurate turbidity measurements have been made results may be predicted fairly closely.

If reducing the turbidity to 1.0 by filtration reduces the bacteria 90 per cent and reducing it to 0.2 reduces the bacteria 95 to 98 per cent, it seems that this increased efficiency is well worth while for polluted waters. These are really conservative figures and may be expected at most any filtration plant.

What Operating Records Showed.—Several years' operating records at the Baltimore filtration plant after it was first put in operation revealed irregularities that were surprising. Having no accurate turbidity measurements on the filtered water it was difficult to place responsibility for the erratic results. We were really quite anxious to improve the quality of the filtered water, for the chlorine required to make the water safe was so high that chlorine tastes were frequent. Every possible cause for the erratic results was investigated, and nothing seemed to offer an explanation unless it was due to the water not being filtered perfectly clear at times. Turbidity measurements on the filtered water were being made at that time by comparing the water with standards of known turbidity in ½ gal. bottles. Our lowest standard was turbidity of 3.0, and I presume any turbidity less than about 2.0 was usually recorded as being zero, especially as we were anxious for the records to show zero readings. It may be possible to detect a turbidity of 1.0 in bottles by making very careful observations, but the average laboratory worker is usually not so careful.

To see if any relation could be established between the clarity of the filtered water and the bacterial removal, turbidity measurements were then made as carefully and accurately as it was possible to make them by bottle comparisons. It was soon found that very poor bacterial removal coincided very closely with slightly turbid water. This pointed to the need of more accurate

turbidity measurements on the filtered water. Then began the effort to perfect some device for estimating low turbidities. Perfection of suitable instruments was not accomplished in a few days or a few months. In fact the work was started in 1918 and it was not until 1921 that success seemed assured.

Developing Turbidity Detecting Devices.—Perhaps it might be well to review briefly some of the early work. It was soon found that there was need both for a laboratory instrument where the turbidity could be measured accurately and for some kind of device for installation on individual filters. Many devices were tried, mostly of our own conception, and considerable money expended. While on a trip in 1918, Mr. Armstrong, filtration engineer of the Baltimore plant, saw a submarine light in the clear water reservoir of the Cincinnati plant. My memory may not be correct as to it being this plant. Immediately he had one installed in the clear water reservoir of the Baltimore plant. This was a great revelation, for the water was frequently so cloudy that we were undecided at first whether to leave the light where it might be observed by all, or to put it in some place where only certain employees would have access to it. It might be said that some such device is almost an essential for every filtration plant if a uniform quality of water is desired. It does not take the place of the instruments that will be described later, for each device serves its own specific purpose. A very good arrangement of the light is shown in Fig. 1.

After installing the light in the clear water reservoir it was thought at first that the light would answer the needs of the filter operators so that as soon as the water showed a slight cloudiness the chemicals could be increased. But it was soon found that increasing the chemicals did not always clear up the water. Finally this was found to be due to flocculated matter passing the

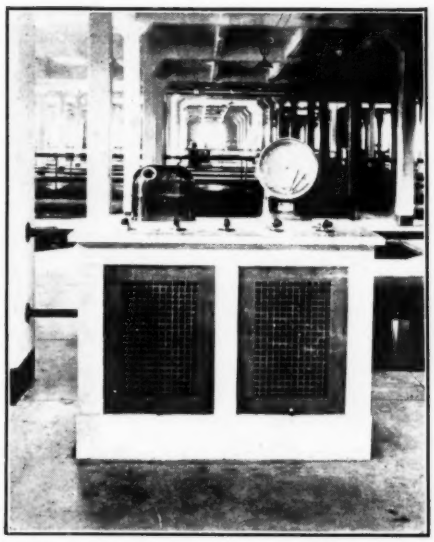


Fig. 3—Floc Detector Mounted on Filter Operating Table

filter beds that were allowed to run 100 to 200 hours between washings. The last half of the time in service frequently passed a large percentage of the coagulated matter going on to the beds. Fortunately the coagulated matter was settled out quite low before the water went to the filters, otherwise the filtered water would have been quite turbid at times from this cause. There was a belief some years ago that a certain amount of the coagulated matter should go to the filters to make them function properly, and that the coagulated water at Baltimore was being settled too clear. The water was settled to a turbidity of 2 to 5 when alum was used for the coagulant. Experiments later proved that for this plant the clearer the water going on to the filters the better.

When it was found at Baltimore that flocculated matter was passing the beds orders were issued to allow filters to run not over 36 hours between washings regardless of the loss of head. Under this order filters were being washed with losses of heads of only 3 to 4 feet in the colder months. However, it prevented flocculated matter from passing the beds. Then when the water showed a slight turbidity in the clear water reservoir it could be attributed to insufficient chemical treatment and increasing the chemicals usually caused it to clear up. A fixed limit on the time between washings could not be regarded as ideal operation, yet it was the best that could be done at the time.

Device for Detecting Flocculated Matter.—In addition to the work which was under way on the laboratory device for making quantitative turbidity determinations, work was started on a device for detecting the flocculated matter which might be installed on the individual filter units. On two occasions it was thought that something had been perfected that would answer the needs of the filter operators. A few of the filters were equipped with the devices only to find that they would not work satisfactorily.

It would be too long a story to relate all the developments leading up to the perfection of the floc detector for installation on filter operating tables shown in Fig. 2 and 3, and the laboratory instrument shown in Fig. 4. Fig. 2 illustrates a homemade instrument and Fig. 3 one along the same lines as manufactured by one of the filter manufacturing companies. A suitable floc detector was developed first. It gave very sensitive detection of the flocculated matter passing the filter beds, but did not give quantitative determinations. A device somewhat similar to the one shown in Fig. 2 was constructed for use in making quantitative determinations. This is shown in Fig. 5. About the only difference is space for two flasks, one of them to contain a standard of known flocculated matter. Quantitative estimation of the flocculated matter has not grown into favor, and there are only a few plants in which sensitive devices have been installed on the filter operating tables. Perhaps there are many waters where such devices are not needed; however, it is believed that there are many plants where they would be of great aid and for some waters they are almost an essential.

Specific Purpose of the Floc Detector.—The floc detector is not much good for observing the fine turbidity, for a fine turbidity of 0.5 to 1.0 cannot be detected. It is very sensitive though for flocculated matter. Particles that would not produce a turbidity of 0.01 are readily detected. The specific purpose of the floc detector is as the name implies, to detect suspended flocculated matter passing filter beds. It is better that it is not so sensitive to the finer particles for it would be more difficult to detect flocculated matter passing the beds. It is very important that the kind of turbidity passing the filter bed be known. If it is flocculated matter

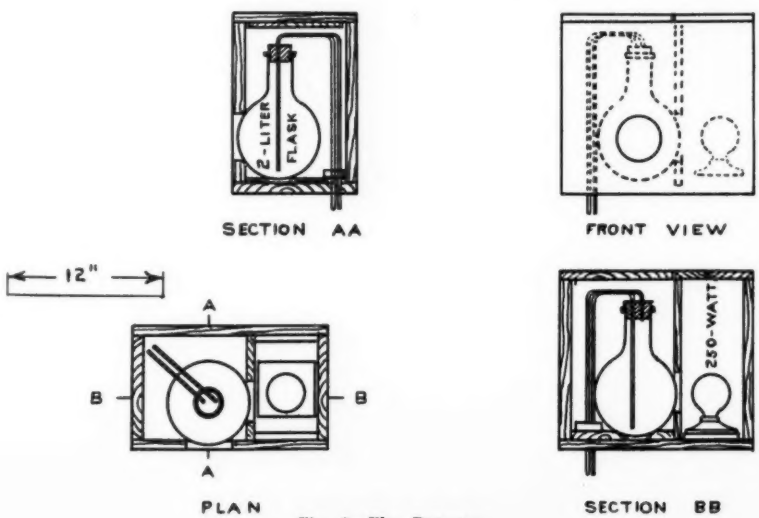


Fig. 2—Floc Detector

the filter should be washed, whereas if it is fine turbidity the chemicals should be increased.

How Turbidity of Filtered Water Was Controlled.—It might be well to relate how the turbidity of the filtered water was being controlled at Baltimore by the plant operators while the writer was there. The filter operators kept a close watch on the submarine light in the clear water reservoir and also made frequent observations in the floc detectors located on the operating tables. If the light in the clear water reservoir showed a slight cloudiness all filters were examined. If none of them showed flocculated matter passing, or so little that it was evident that this could not be responsible for the cloudiness the matter was reported to the chemical controller attendant who had instructions about increasing the chemicals. If the chemist was on duty it was also reported to him so that he might give additional instructions if necessary.

A turbidity of 0.2 is readily noticeable in the clear water reservoir if the light is under 6 or more feet of water and is near a concrete floor or some other dull surface. Just why a dull surface like that of concrete gives better detection of the turbidity is not known, but it is a fact nevertheless. Some have made the mistake of having a white surface on the bottom of the reservoir with the belief that it would show the cloudiness better. A white surface is all right directly under the light as shown in Fig. 1, but the white surface should not be more than 18 to 20 in. in diameter. Another mistake that is frequently made is not providing enough space around the light. The light may be near a side wall but there must be plenty of space away from the wall. What is seen is a reflection of the light from the particles in suspension and it is evident that the particles must not be directly over the light. Looking at an angle of 10 to 20 degrees from a line direct to the light seems to give the best results when the eyes of the observer are 8 to 10 ft. above the water surface. In other words, the area of the most sensitive turbidity detection is a circle around the light and not the area directly over the light.

The light in the clear water reservoir is just as indispensable as the floc detectors, for it is at this point where water that has not received sufficient chemical treatment is first detected. The light should be located where the water can be observed shortly after it has passed the filters, otherwise it will take a longer time to get the treatment corrected. It is true that water greatly undertreated may be detected by skilled operators after it passes the mixing basin, but slight undertreatment which will cause the turbidity to increase a little in the filtered water cannot be detected until after it passes the filters.

The Laboratory Turbidimeter.—The purpose of the laboratory turbidimeter shown in Fig. 4 is for making accurate quantitative measurements. It was selected as the most suitable means of measuring the turbidity of filtered water after many devices had been tried. A practical instrument must not be too cumbersome and it must give comparisons easily distinguished; that is, it must give comparisons whereby a turbidity of 0.2 is readily distinguished from a turbidity of 0.1 or 0.3. The first attempt to measure low turbidities was to pass rays of light through water in a dark room, somewhat in the principle of a Tyndall meter. The results were none too encouraging or at least it did not seem that an instrument along this line would be practical for routine turbidity measurements. Long tubes with a light underneath were tried next. An instrument using two-inch glass tubes 5 ft. long was constructed. This was a little improvement over the way turbidity measurements were being made in bottles prior to this time. On the basis of the long tube experiments eight of the filters in the plant at Baltimore were equipped with iron tubes about 8 ft. long, having a glass plate at the bottom and a light underneath the glass. This was prior to the perfection of the floc detector. It was soon found that turbidities readily noticeable by the light in the clear water reservoir could not be distinguished in the long tubes.

Even though the long tubes for the filters were a failure, use of the device containing the 2-in. glass tubes was continued in the laboratory. It was at least better than comparing with standards in bottles. Perfection of the floc detector suggested that a side light for the tubes might be better than one underneath. Various arrangements of the light and the tubes were then tried. Finally an instrument along the lines of that shown in Fig. 4 was tried. The glass tubes used at first were the 75 cm. tubes for the Jackson candle turbidimeter. This did not give very good results. Then colored light were tried, which finally led to the present instrument. So many things had been tried and resulted in failure that many things were being tried with not much idea of what might be expected. Blue is not the only colored glass that may be used,

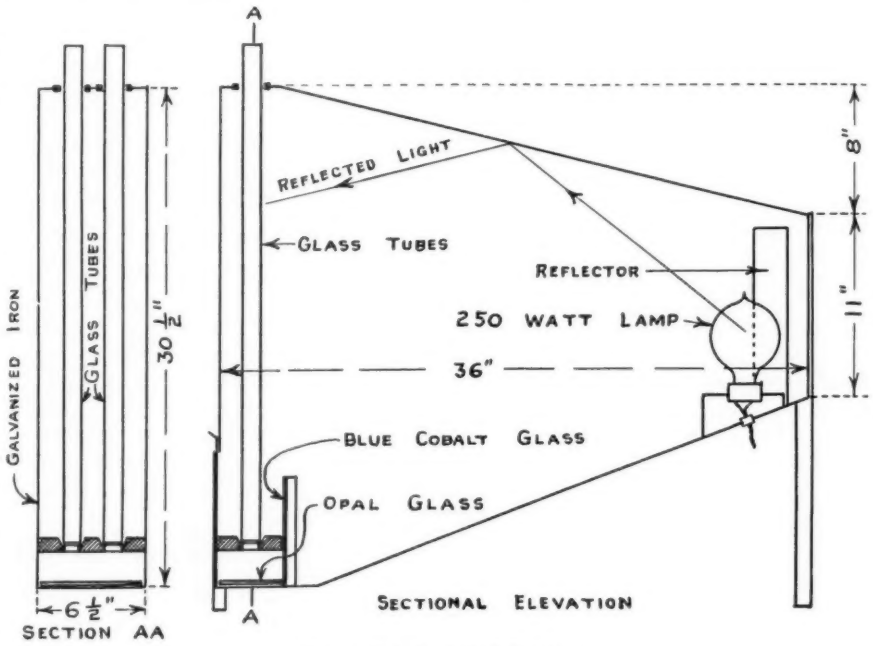


Fig. 4—Details of Turbidimeter

but blue is a color in which variations in the shade are easily distinguished.

In attempting to make the instrument extremely accurate for low turbidities the range it covers is not great. The most accurate comparisons can be made when the turbidity is between 0.0 and 1.0, but it is suitable for comparisons up to a turbidity of 2.0. Some are of the opinion that if it had been made a little less sensitive and covered a wider range of turbidity that it would be more useful. This may be true, but when it is desired to produce water in which the turbidity is not more than 0.2, it seems that something in which a turbidity of 0.1 may be readily detected is desirable. There is no fault to find with other instruments, and it is hoped that one even more simple and useful will be perfected. It is believed, however, that the present instrument is sensitive enough for water works laboratories and will answer the purpose in case nothing more convenient and cheaper is devised.

Turbidity Measurements.—The best procedure for making turbidity measurements is to first test the total turbidity with the instrument shown in Fig. 4. This instrument and the procedure for making the standards and the test is explained in two articles

which have been published already*. Record the results as the total turbidity, for it includes all the suspended matter. If a floc detector as shown in Fig. 5 is available use it for determining the floc turbidity. Subtracting the floc turbidity from the total turbidity should give the fine turbidity. If no floc detector is available fairly good results may be obtained by filtering the water, after the total turbidity determination has been made, through a No. 12 Whatman folded filter paper. The paper should be washed thoroughly by filtering through at least one liter of clear water. It may then be used for filtering several samples of water if only a small quantity of flocculated matter is present. It should not be used after it begins to show signs of clogging. Test the filtrate for turbidity the same as for the total turbidity and record the results as the fine turbidity. The difference between the total turbidity and the fine turbidity should give the approximate floc turbidity.

An arbitrary standard of 0.2 fine turbidity and 0.05 floc turbidity has been set by the writer as that beyond which the water should not exceed. This seems to produce water that is satisfactory in every respect for domestic uses. In the practical operation of filtration plants the coagulation should be increased if the fine turbidity exceeds 0.2 and it may be reduced if the turbidity is less than 0.2. When the floc turbidity exceeds 0.05 the filters should be washed more often, and when it is less than this amount the filters may be allowed to run until the loss of head reaches the maximum. If only the total turbidity is measured, and it exceeds 0.2, there is no way of telling whether it is due to fine turbidity alone, floc turbidity, or a mixture of the two. Table I gives the daily records for a period of several days on two occasions in which the filtered water of a certain plant materially exceeded what it should have been. Twenty days are given. It will be noted that out of the 20 there were 8 days in which the fine turbidity exceeded 0.2 and the coagulant should have been increased and that there were only three days in which the floc turbidity did not exceed 0.05. For some of the days both the coagulant should have been increased and the filters washed more often. There were 6 days in which the fine turbidity was not over 0.1. On these days the total turbidity was high, yet the coagulant could have been reduced. It might be well to state that these records are not typical of average operating conditions for this plant. They were the two worst conditions experienced at the plant. The average results were good.

*Baylis, John R. J. Am. Water Works Assoc., 11: 4, 284, July, 1924. Ind. & Eng. Chem., 18: 3, 311, March, 1926.

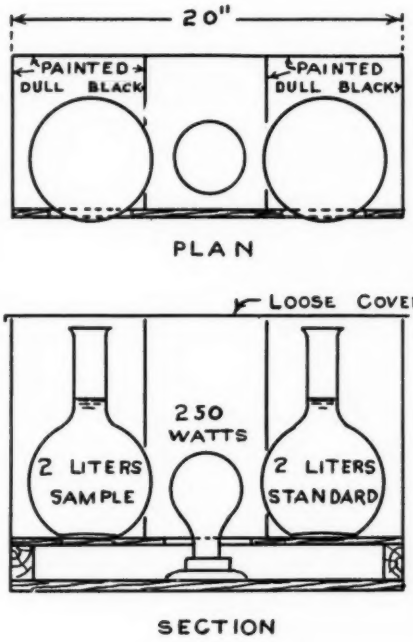


Fig. 5—Laboratory Floc Detector

Accurate turbidity measurements on the filtered water are of great aid in the efficient operation of any filtration plant, and it is evident that the cause of the turbidity should be known. No one device will answer all purposes though it may result in improved operation. It is true for some waters that there is not much danger of flocculated matter passing the filters, and in these cases there is not much need for the floc detectors, yet they should not be omitted unless several years of careful observations show that they are not needed. Even then they would be worth the cost to detect occasional breaks in the beds.

Table I—Turbidity Measurements Showing the Importance of Determining Both the Fine Turbidity and the Flocculated Matter

Date		Total Turbidity	Fine Turbidity	Floc Turbidity
Jan.	13	.2	.2	.04
"	14	.3	.3	.04
"	15	1.5	.4	1.00
"	16	1.0	.2	.80
"	17	2.5	.1	2.40
"	18	2.5	.1	2.40
"	19	2.5	.1	2.40
"	20	1.0	.1	.90
"	21	4.5	.1	4.40
"	22	7.5	.1	7.40
"	23	.8	.2	.60
"	24	.2	.2	.04
Sept.	18	1.0	.8	.20
"	19	1.3	1.1	.20
"	20	1.5	1.3	.20
"	21	.3	.2	.10
"	22	.3	.2	.10
"	23	.3	.2	.10
"	24	2.0	.6	1.40
"	25	2.0	1.0	1.00

Acknowledgment.—The foregoing is a paper presented, Feb. 4, 1929, before the Kansas Water Works Association and the Seventh Annual Three Day School at the University of Kansas, Lawrence, Kans.

Service Lines

Useful Information on Installation and Care

By W. C. HAWLEY
Chief Engineer and General Superintendent, Pennsylvania Water Co., Wilkinsburg, Pa.

ONE of the most important things in the installation of service lines is the tapping machine, with which the main is drilled, the hole tapped and the corporation cock screwed into place under pressure; that is without the necessity of shutting off the water pressure by closing gate valves in the main. In choosing be sure to get a machine which has been used by others satisfactorily under similar conditions and one that is not too heavy for easy transportation and handling.

Tapping the Main.—The main should be tapped at an angle of about 45 deg. from the vertical where there is any danger of frost. Where there is no such danger it may be tapped on top and thus provide a means of escape for air which may accumulate in the main.

Many water works men believe that a corporation cock larger than the 1-in. size should not be used and even the 1-in. size is not used by some, where pressures are high. This avoids the danger of splitting the pipe by the wedge action caused by screwing the corporation cock into the main. Where 1½-in. or 2-in. service lines are needed it is better to insert two or more ¾-in. or 1-in. corporation cocks at safe distances from each other and staggered, that is not put in along the same line on the main, thus avoiding the danger of splitting the pipe as explained above. Where two or more corporation cocks are used they can be connected with goose necks to a header attached to the larger pipe.

Service lines should be laid at depths sufficient to protect them from frost. This depth will vary according to kind of soil and the amount and degree of cold weather to be expected and no chances should be taken. Remember the winter of 1917-18.

Laying the Service Line.—A service line should be laid at right angles to the street in which the main is laid and it should not be laid in a sewer trench as any leakage will probably find its way into the sewer instead of going to the surface. The only exception to this rule should be when the trench is in rock and then the sewer trench should be at right angles to the street and not at about 45 deg., as sewers are usually laid, and the water pipe should be placed on a bench on the side of the trench at the proper depth.

The service line to the curb should be laid by competent and experienced men. The consumer's service line should be inspected in open trench to insure its being of proper material and workmanship and at proper depth to make it safe from frost. Our company

has found it advisable to have the consumer's service line laid first and inspected. The company's service line is then laid and the connection at the curb to the consumer's service line made by the water company's employes.

Capacity of Service Line.—The capacity of a service line depends upon the pressure at the main, the length of the service line, its internal diameter and the character and condition of its interior surface. The pressure and the length are known quantities. The character of the interior surface and its future condition are matters determined by judgment and experience, so that the only really unknown quantity is the diameter, and the proper diameter will depend upon the demand made upon the service line by the occupants of the premises supplied through the various fixtures installed for water service. For the ordinary dwelling a demand of about 1 cu. ft. per minute is not unreasonable. As the number of people and fixtures increase the demand will be increased correspondingly. With normal pressures of 60 to 100 lb. and streets of 60 to 80 ft. width and houses at 20 to 30 ft. back from the curb line, a ¾-in. service line in good condition should meet the demand of the ordinary family. We must recognize, however, that with the installation of fixtures requiring water delivered at rates in excess of those which were demanded a few years ago, such as laundry trays with ½-in. spigots, shower baths, etc., we must be prepared to deliver water at rates somewhat in excess of those which were adequate a few years ago.

Methods of Removing Deposits.—With some waters there is a tendency for the deposit of silt or oxides of iron and manganese in the service lines, which in course of a few years may cause noticeable reduction in capacity. If this is likely to occur, it must be taken into consideration in deciding upon the size of service line which is necessary.

Incidentally, there are methods of removing such deposits in lead or other pipes with smooth interior surfaces without the necessity of taking up the service line or going to large expense. The use of a tissue paper plug forced through the service line by a force pump has given good results where the pressure in the main is not too high. The paper soon disintegrates and is not objectionable. Gum drops have been used for the same purpose and one of the best materials is coarse salt. The latter can be used when pressures are high.

Demand for Larger Service Lines.—In recent years there has been a rather general demand for larger service lines and meters as well, due to the introduction of Flushometers. If these fixtures used larger quantities of water it would be easier to convince the average water works man that the water utility should increase its investment in service line and meter for the purpose of giving such service. The fact is, however, that the Flushometer probably reduces somewhat the total amount of water used, and sooner or later it causes water hammer. In some places the demand for larger service lines has been granted, but in most places it has been refused and the satisfactory use of the Flushometers has been made possible by the installation of an air tank connected to the water pipe in the building supplied.

It is difficult to convince a consumer that he should not be given a large service line. He will argue that he wants a connection to the main which will give service on the second or third floor whether water is being drawn in large quantities in the basement or not. He does not appreciate the increase in investment required to give that kind of service nor that the amount of water used will not be materially increased. Explanations to the effect that a large meter is not as sensitive on small rates of flow are not appreciated by him. The most effective argument is in the case of a water utility which has a service charge based upon the size of the service line or the size of the meter. He can understand and appreciate a larger service charge, especially when it does not pay for any water.

The rules of most water utilities provide that there shall be but one service line to each property supplied, except sometimes in the case of large buildings. This is a reasonable rule and has been approved by Public Service Commissions. There is no good reason for the water supply for a building being taken from two or more service lines with two or more meters to be looked after and maintained and two or more accounts to be kept.

Laying Service Lines to Vacant Lots.—The demand that service lines should be laid to vacant lots, etc., before pavement is put down is one which has caused much trouble. Where it has been tried it has been generally unsatisfactory. No one can foretell the size of a building which will be erected on a lot at sometime in the future, nor what will be the demand for service. Wide lots are frequently subdivided into narrower ones so that the service lines which have been put in are too few. The proper location of the service line cannot be foretold and many service lines which have been put in before paving have never been put into use. The Public Service Commission has refused to compel the water company to install service lines before pavement is laid. It is probable that no type of pavement has as yet been put down which cannot, with proper care, be replaced when it is necessary to cut through it to lay a new service line or make repairs. The back-filling of trenches and the replacing of such pavements demand the utmost attention on the part of the water works manager and the work should be done so that it is not a source of reasonable complaint on the part of the municipality.

Back Filling Trenches.—In places where crushed slag can be obtained it is becoming quite customary to use it for back-filling trenches after 10 or 12 in. of clay or earth has been placed and tamped over the pipe. The slag can be wet and tamped into place without danger of further settlement to any extent. Temporary pavement can be put over it and in two or three weeks it is ready for the placing of permament pavement with no danger of further settlement. A better arrangement would be for the municipality to take over the back-filling of all trenches and the replacing of pavements over them for which the water utility would pay a reasonable fee.

Service Line Records.—And one thing more. There should be kept a record of every service line, showing its size, material, length, location, etc. This data should not only be written but there should be a sketch so that it will be possible with the information given to go out onto the street and by making two to four measurements locate the service line accurately. These measurements should at least be from the property line of the intersecting street and from the curb to the tap. There should be two or three check measurements from objects as nearly permanent as possible, such as a fire hydrant, a gate valve box or the corner of the curb or from the corner of a building. Measurements from trees, telephone or electric light poles, etc., are not of much value, as trees are cut down and poles are moved. Even curb lines are changed at times, but there should be enough measurements made so that although one or two of the objects from which they are made are moved, it will still be possible to locate the service line. In these days of permanent pavements it does not make the municipal authorities feel very good and it is expensive to have to dig through the pavement in three or four places to locate a corporation cock when it might have been avoided by the keeping of proper records. Such records should be checked and brought up to date at every opportunity. Curb boxes should be maintained in good condition with the tops at the proper elevations and if service lines have always been put in at right angles to the street the location of the corporation cock can be found at least approximately if the distance of the main from the curb is known. The curb box should be inspected every few years and kept in good condition, ready to operate in case of a leak doing damage in the property or the necessity of shutting off for neglect to pay bills, etc.

Acknowledgment.—The above is an abstract of a paper presented at the last annual meeting of the Pennsylvania Water Works Association.

Meter Accounting and Reading by the Water Department of Detroit

How Detroit Reads 245,000 Meters

By W. C. BOWEN

Supervisor Assessment Bureau, Department of Water Supply, Detroit, Mich.

THE Assessment Bureau is chiefly concerned with the problem of determining how much water is delivered to each of the department's 245,000 customers through an equal number of service lines, and such other activities as are naturally allied.

Ninety-nine per cent of the service lines are metered, which fact goes a long way towards solving the problems of the bureau. It is, however, no small task to read 245,000 meters at least four times a year and many of them more often. To accomplish this in the most satisfactory manner the following plan was worked out and put into operation two years ago and is proving to be by far the best system that has to date been tried.

City Divided Into 36 Districts.—The city was first divided into three zones, each having approximately the same number of meters within its boundaries, and were named Eastern, Western and Central. Each zone was then divided into twelve districts. Considering the number of meters in service at that time it was necessary to so divide the zones that each district would have about 7,000 meters. Districts were so numbered that the number of the district not only designates the district but also the zones, namely, districts of the Central zone were numbered from 11 to 22, inclusive, Western from 41 to 52, Eastern from 71 to 82. The intervening numbers were left for expansion.

It is now noted that the city has been divided into 36 districts, each of which must be read once every three months, making it axiomatic that one zone or twelve districts must be read every month. As there is but an average of 24 working days to a month it is seen that only two days could be allowed for the reading of each district.

1,685 Route Books.—Districts were then divided into routes, each containing a sufficient number of meters to constitute one day's work. The number of meters in each route vary in accordance with the territory ranging from 120 meters in business and factory centers to 180 in some residential sections. Each route was given a number so that, being given district and route any reading sheet can be immediately located. Reading sheets for each route were then locked into a specially designed binder, upon which was printed the district and route. We have at present 1,685 of such route books. They are filed in a specially designed cabinet in such a manner as to be most readily procured. A card index system, wherein streets are arranged alphabetically and in rotation as to house numbers, serves as a key to the route books.

Readers report each morning to the main office, turn in the books completed the previous day, receive the books assigned them for that day and immediately set out for their route. It is well understood that, barring mishap of some kind, no excuses will be accepted for failure of a reader to complete his route.

Checking by Assessment Clerks.—Following completion of route books they are scanned by assessment clerks, who go over each book, sheet by sheet, checking the readers' computation, considering the probable correctness of each reading, ordering check readings where necessary, writing up "pick up slips" for all meters that were for some reason passed by the reader, reporting meters out of order and new jobs ready for meters, computing and entering construction service charges, estimating consumption (of which more will be said later), as well as various other details that are necessary in order to get the books in shape to turn over to the billing bureau.

As above mentioned, meters that were passed by the readers are caught by the assessment clerks who make out pick-up slips. There readings are obtained the following day by a group of readers known as "pick-up men." Any meter passed by this group or about which additional information is desired is turned over to the night reader, meter reader foreman or chief inspector, as the case may be. From this it is noted that the route books are a long way from being ready to turn over to the billing bureau when turned in by the readers as completed.

Delivery of Bills.—The Assessment Bureau is also responsible for bill delivery. Six men are assigned to this work. All bills prepared one day are delivered the next day. The schedule calls for the bill to be in the customer's hand 15 days after the first call of the reader. Ways and means are now being considered as to how this period can be still further shortened.

Method of Estimating Consumption.—We believe that a special paragraph describing our method of estimating consumption is deserved, for there is no other duty of the assessment clerks that requires that fine degree of good judgment and application of common sense as does estimating the amount of water consumed by a certain customer during a definite period. It is probably needless to say that this method of arriving at a consumption is resorted to only after all other methods have failed, but even at that, unfortunately the necessity often arises. An average of 3,500 accounts are checked each day by the assessment clerks and of this number there is an average of 300 accounts that for some reason no reading could be obtained. The most common reason is the inaccessibility of the meter and next to that the fact that the meter does not indicate true consumption. An estimation in case of the former is not so serious, as a reading will eventually be obtained at which time any error in estimation is corrected; but where the meter is out of order, that's different: there will be no later reading. Our estimates vary from a few hundred feet to a few million feet or as expressed in money from the minimum bill of $1.25 to well over $1,000. There can be no definite rules set up to govern estimates as there are no two cases just alike. Our limited space forbids a detailed treatise on this subject, but sufficeth it to say that all available information, such as a record of past consumptions and a report on present conditions at the premises is gathered together and considered before the estimate is made. Often in case of large consumers a personal call to the premises is made when an opportunity is given the owner or an official of the company to express his opinion as to the probable consumption. We have found the large consumers, particularly large institutions, always ready and willing to co-operate and meet us half way in a matter of this kind.

Construction Service Charge.—Provision has been made for supplying water for building purposes by installing services before there is any possibility of setting a meter and allowing use of the unmetered line until the building is completed and occupied. While this arrangement is a decided accommodation and convenience to the builder and owner, it is just another problem for the assessment bureau, which much determine how much water was used through each service before

the meter was installed. After trying several plans with more or less unsatisfactory results, the plan now in use was decided upon and is working out very satisfactorily. The idea of estimating the consumption or assessing a fixed charge known as the building tax for each new building and varying according to types, was given up and superseded by a monthly flat rate charge known as construction service charge, same to run from the date of service installation to the date of meter installation. This charge is applied only to ¾ in., 1 in. and 1½ in. services, which constitute 95 per cent of the total.

After considering the amount of water actually required for construction of certain type buildings, the average amount wasted, the usual type of building using a ¾ in., 1 in. and 1½ in. service, the rate of $.75 per month for ¾ in. and $1.50 for 1 in. and 1½ in. service was adopted as being sufficient to cover in the aggregate the cost of this service.

Under this plan accounts are opened on the day service is installed and allowed to run until meter is installed and up to the time of the next regular billing period, at which time the number of months of unmetered service is noted and multiplied by the proper monthly rate, which amount is billed as the construction service charge. Considering that there is an average of seventy new accounts opened daily the year around it is readily understood why this plan is popular with the assessment bureau, as each account is handled in precisely the same manner, whereas under the old plan each new account had to be individually considered; not only that, but it establishes a definite date of collection and a definite rate. It removes all opportunity for a customer to complain that he was charged more than his neighbor for like service, or that he obtained his water supply for building purposes from the county ditch.

For the benefit of the customers who dislike this flat rate plan, arrangements have been made to install meter at any time upon request of the owner, provided that proper preparation has been made for its reception.

Service lines over 1½ in. in diameter are used by buildings of such various types and sizes that this plan is not applicable. In all such cases the building tax is arrived at by ascertaining the amount of the various materials used in the building and applying the rate so based as has been adopted by the board. To this is added the regular service charge for the period of unmetered service, the total being the building tax.

Special Readers for High Consumption Meters.—High consumption meters are read monthly by special readers whose duty it is, in addition to reading, to see that they are so functioning as to constantly indicate true consumption. Frequent tests and minor repairs are made on the job. They have so arranged their routes that one of their regular readings will be made at the time of the scheduled billing reading. These readings are turned over to the assessment bureau where they are transferred to the regular reading sheet and the accounts prepared for billing.

As has been before mentioned 99 per cent of the service lines are metered, the other 1 per cent for various reasons are not. These few accounts are carried on assessed rate, the rate being determined in the usual flat rate method of basing it on the number of openings and the purpose for which the water is used.

Special Assessment Record. — The board's desire to furnish water for every legitimate purpose and in the manner most convenient for the consumer has necessitated the keeping of a special assessment record. Every day applications are made for temporary water service, and in those cases where a permanent service installation would not be practical nor the expense justified, the applicant is given permission to use a fire hydrant.

It is the assessment bureau's problem to determine how much water is used for the above mentioned purposes and in what amount each permit holder is to be billed. A clerk, known as special assessment clerk, is assigned to this work. A description of our methods of determining water consumption in such cases would be too lengthy to be included in this paper, as it is obvious that there must be a different method for nearly every case, but as an illustration we will cite that of pavement construction.

At the end of each paving season we obtain from the records of the department of public works the amount of paving done by each contractor. From these records the yardage of concrete is computed. Yardage times known amount of water required per yard plus a certain percentage for wastage equals approximate amount of water consumed.

During the year 1926 $11,810.55 was paid to the department for the use of water from fire hydrants ranging in amounts from $1.00 to $3,537.65.

The assessment bureau receives and investigates all service bill complaints. It is the aim of the bureau to go full length to satisfy each and every customer by check readings, and investigating for cause of high bills. Very few complaints are carried to the adjustment committee of the water board.

The bureau has charge of the addressing machine room consisting of the addressing of water bills, making of addressograph plates, printing of forms and notices used by the department of water supply and allied work.

Acknowledgment.—The foregoing is taken from a descriptive survey of the Detroit Department of Water Supply, issued last fall by the department.

Revenues and Expenditures of Cities

The U. S. Bureau of Census, Department of Commerce has just issued a bulletin giving the financial statistics of cities having a population of over 30,000, the figures being for the year 1927.

Assessed Valuation and Tax Levies.—For the two hundred fifty cities having a population of over 30,000 the assessed valuation of property subject to general property taxes for city purposes amounted to $74,731,205,845, or a per capita of $1,749.47.

The total levies on the property subject to general property taxes in these cities for the governments of the cities, counties, states, school districts, and all other governmental units for all purposes amounted to $2,278,379,544, or an average for each person of $53.34.

Revenues.—The total revenue receipts in 1927 of the 250 cities having a population of over 30,000 were $2,945,511,729, or a per capita of $68.96. This was $713,084,994 more than the total payments of the year, exclusive of payments for permanent improvements, but $378,874,622 less than the total payments, including those for permanent improvements. In only seventy of the cities was there sufficient revenue to meet all payments during the year. The payments in excess of revenue receipts were met from the proceeds of debt obligations.

Governmental-Cost Payments*.—The total cost of government in 1927 of the 250 cities in this class amounted to $3,324,386,351. An analysis of this total shows that the costs for the operation and maintenance of the general departments were $1,750,707,093, a per capita of $40.98, and representing 52.7 per cent of all costs of the 250 cities; operation and maintenance of public service enterprises, such as waterworks, light plants, public markets, and similar enterprises, $162,470,940, a per capita of $3.80, and 4.9 per cent of the total; interest on debt, $319,248,702, a per capita of $7.47, and 9.6 per cent of the total; and for outlays, or permanent improvements of general departments and public service enterprises, $1,091,959,616, and 32.8 per cent of the total cost.

Expenses for Operation and Maintenance of General Departments: 1927

	Total (000 Omitted)	Per Capita
All general departments	$1,750,707	$40.98
General government	148,061	3.47
Protection to person and property	350,341	8.20
Health and sanitation	176,996	4.15
Highways	157,198	3.68
Charities, hospitals, and corrections	106,492	2.49
Education	668,263	15.65
Recreation	60,364	1.41
Miscellaneous	82,992	1.94

*The governmental-cost payments include all payments for the year, whether made from current revenues or from the proceeds of bond issues. The proceeds from the issuance of debt obligations are not considered revenue receipts.

Unusual Conditions Discovered through Pitometer Water Waste Surveys

A Discussion of Particular Interest to the Water Works Superintendent

By H. E. BECKWITH
District Manager, The Pitometer Co., New York, N. Y.

IN the 30 years our company has been conducting water waste surveys improvements in our methods of operation have come as often from the criticism and helpful hints of persons outside our organization as they have from the development of new ideas on our own part. Consequently, in calling to your attention those conditions which we have encountered in our work, I am not prompted by any unholy joy in pointing out the mote in my brother's eye. It is rather by way of returning in small measure the helpful courtesies shown us by the men in the water works field, and with the hope that you may find some helpful hint in the conditions we have found in other plants.

When the Valves Were Closed.—It is, of course, very common for us to find closed valves. Your attention is called to two such instances: In the first of these an entire town of some 20,000 persons was being fed through four 6-in. mains, because a valve on the main 16-in. feed was closed. Moreover, this was the only valve in the entire system found closed, showing that care was taken to check up on the valves. Furthermore, and this is of special importance, it was the only geared valve in the system. When the operating nut on the gear was turned in a clockwise direction, the valve stem was turned counter-clockwise. As the valve stem on this valve closed in the same direction as all other valve stems in the system, it was necessary to turn the operating nut in the direction opposite to that of every other operating nut in order to close the valve. Someone failed to take this into consideration, with the result that the valve had been kept habitually closed.

In the second case, the hydraulic grade line was apparently lower at one point than it was at another point on the same line, ¾-mile further from the source of supply. This was on the system of a small company serving several miles of territory with laterals feeding directly off one long main, or rather it had been one long main originally. For 1½ miles of its length it had later been paralleled with another main. This second main was tied to the original main at no place other than at its ends, and no laterals came off of it. A study was being made for the purpose of reinforcing the system. When the hydraulic gradient for the system, as determined in the field, was plotted on cross-section paper, it was found that midway between the ends of the two parallel mains the hydraulic grade line was lower than at either end. Subsequently, the valve on the reservoir end of the "old" main was found to be closed. All water being used along the mile and a half of parallel mains had to go to the farther end and then feed back toward the reservoir. Opening the closed valve, of course, took the sag out of the grade line and increased pressure below the point where the valve had been closed. The trouble in this case was caused by right and left-hand valves being indiscriminately sprinkled throughout the system. Volumes could be written about the trouble caused by indiscriminate use of both right and left-hand valves in the same system. This is merely another example of the results of this practice.

Why the Supply Main Delivered No Water.—Speaking of hydraulic gradients, there is the case of the city whose officials had believed their system was being fed by two mains from the reservoir. A pitometer test proved, however, that there was no flow through one of these pipes. Further investigation showed that this main at one point actually lay above the water-level of the reservoir. After the line was lowered, its vacation was over and it went to work delivering water to the city.

Accounting for a 50 Per Cent Loss.—Another very interesting case was that of a city which had originally been served by two separate companies. Later, these companies were merged and the distribution system was interconnected. Each of these companies originally secured its water by gravity from a mountain reservoir, the reservoir of one company being 12 ft. higher than that of the other company. Since the complete metering of this system a few years ago the meters through which water was sold had accounted for a little less than 50 per cent of the water shown on the Venturi meters installed at the reservoirs. Our tests showed that during the night, when the use of water in the system dropped low, the water fed out of the higher reservoir into the lower. It is the nature of a Venturi meter to measure in a positive direction the water which goes through it, regardless of the direction of flow. Consequently, the water which fed from the higher to the lower reservoir was measured on each of the two Venturi meters, although as a matter of fact, it was never used in the distribution system at all. When the Venturi meters were originally installed the city was on a flat rate basis, and the waste of water was so large that it is doubtful if the water ever backed up into the lower reservoir. But with the metering of all the services the amount of waste gradually fell off until the condition prevailed of which I have just spoken.

Whenever a water system is fed by gravity from two or more reservoirs on different levels, it is well to grow immediately suspicious of back-feeding when the supply in the lower reservoir holds up better than the supply in the upper one.

Incorrect Meter Reading.—Another very interesting case was that of a small suburban city which purchased water from its larger neighbor by meter. As the city was being paid on its meters for less than half the water entering the distribution system, the water department had accummulated a large deficit. In addition to the conditions usually found by a survey, it was discovered that two 4-in. and two 6-in. meters were being incorrectly read, and that the city was being paid for only 10 per cent of the water going through them. The value of the water which had passed through the meters, but which had never been paid for, was nearly equal to the deficit of the department. An effort was made to collect this money on the grounds that the bills rendered the consumer bore the meter-readings and his acceptance and payment of the bills constituted an acceptance of the correctness of the meter-readings. As the department did not use a step rate, the matter of billing was comparatively simple. It is to be regretted that we cannot advise you as to the outcome of this attempt to collect, as we left the city before any settlements were made. Two of the consumers had, however expressed a willingness to pay; and I understand that the state commission had ruled that any failure on the part of the city to collect the full amount would be equivalent to the granting of preferential rates and would therefore be contrary to law.

This under-reading was caused by the fact that the smallest dial on the meters involved was graduated in units of one hundred, whereas the smallest dial on

all other meters on the system was graduated in units of ten. The meter-reader entirely overlooked the necessity of investigating the meter to determine in what units it was graduated.

How to Prevent Inaccurate Meter Reading.—That this is not the only case of its kind is shown by the fact that another similar condition was recently found. As a remedy for this it is suggested that meter-readers be not permitted to take their previous readings on a meter into the field and so help to carry the error through. It is further suggested that the office clerks be forbidden to change any readings in order to make them conform to previous readings. Wherever a doubt exists as to the accuracy of the reading on a large meter, it would be well to have it checked by the meter company's representative.

In another suburban city, which also purchased its water through a meter, periodically the receipts from the water department would drop below the cost of its water. The trouble in this case lay in a compound meter to a steel mill. The high duty side of this meter was dead; and whenever business was sufficiently good with the steel company to cause a draught of water large enough to throw the flow onto the high duty side of the meter, business was very bad with the water department. Another factory in a different part of the city had been suspected of stealing the water, which is probably the one reason why the real cause of this lost water was not discovered before.

In the same place the larger city had metered two services, and had for years been collecting revenue from them, when, in reality, the services were attached to the mains of the smaller town. Both cities had mains in this one street. In this case, all moneys that had been so collected were turned over to the smaller town.

The Source of the Spring.—In another suburban borough which purchased water by meter, the newspapers stated that the leak discovered by the survey had been running for twenty-five years and had cost the borough in that time a quarter of a million dollars. This is not of particular interest here, except as it lends point to another statement made by the same news article. It seems that, when a large sewer was laid past this leak, it was impossible to handle the water with a pump. It was decided that a spring had been tapped and special foundations were put in to protect the sewer. It should be noted here that the leak was from the open end of an abandoned service of which the borough had no record. In view of the known heavy losses, it is certain that the leak would have been discovered when this sewer was laid, had the water come from the direction of the main and not from the direction of a vacant lot.

It is remarkable how many springs, and swamps even, dry up after leaks on the water system are repaired. And how many people lose their source of valuable medicinal water.

Unauthorized Uses of Water.—Several years ago, when the stock of privately owned water companies was more or less a drug on the market, and few companies had paid dividends in many, many years, we caused considerable consternation on the part of the president of one company where we were working. It developed that a certain manufacturing company in the city was getting about 100,000 gal. of water a day free, through a defective meter. The president of the water company was also president of this factory. It was bad enough, he felt, not to get any dividends on his water company stock, without having the dividends of his factory cut into by increased water bills.

In another case we were called in to locate the cause of a large amount of water escaping from the high pressure system of a middle sized city. By a quirk of fate, it was discovered that 300,000 gal. per day of water were being surreptitiously taken from the system by a plant which was largely the property of the water commissioner. And he was the man who had been most instrumental in securing the commission for us in the first place. Certain it was that this water was being taken without his knowledge.

As a matter of fact, we find it generally true that, where water is being taken in an unauthorized manner, it is done without the knowledge or consent of the higher officials of the companies. It is usually some department head who wants to take a short cut to a good showing for his department.

Low Pump Discharges.—In recent years there has been a rapid increase in the development of electric power, with the result that many water plants have found it economical to substitute electrically driven centrifugal pumps for the old steam plant. Unfortunately, a full realization of the limitations of this type of pumping unit does not seem to have accompanied its installation. In only too many cases the only requirement placed on the pump is that it pump water. No apparent consideration is given to the efficiency with which this work is done. The displacement type of pump allowed so much latitude in operating conditions that many plant operators have not yet come to a full realization that centrifugal pumps operate efficiently only under the design head, and at the design rate of discharge.

No branch of work being done by our firm is more interesting than the efficiency tests on electrically driven centrifugal pumps. In one instance the pumping units were two 2,500,000-gal. pumps, working in parallel to give a combined output of 5,000,000 gal. per day. These pumps were designed to work against a head of 100 lb. The time came when these pumps would not carry the maximum day load. So the output was increased by putting the discharge of these two pumps through a 5,000,000-gal. pump designed to pump against a head of 50 lb. This gave, then, an installation designed to pump 5,000,000 gal. against a head of 150 lb., whereas it was working against a head of only 100 lb. This gave an increased rate of discharge, but at a considerable cost in efficiency. This was not the sole reason why the wire to water efficiency of the installation was under 44 per cent, as several pieces of wood were later taken from the ports of one of the pumps, but it did have a very important bearing on the loss of efficiency. It is of interest to add that, after disconnecting the 50-lb. pump from the discharge of the 2,500,000-gal. pumps, and cleaning these latter out thoroughly, a subsequent test on these two pumps gave an over-all wire to water efficiency in excess of 70 per cent.

In another instance the clear well was of such small size that it was necessary to coordinate the flow from the filters into the clear well with the pumpage out of it. As the low lift pump from the river to the filters had a higher rate of discharge than had the pump from the clear well to the distribution system, this coordination between the two pumps was secured by partially closing a valve on the discharge of the low lift pump. This increased the head at the pump above its design head and induced a slip into it. So much was this increase in head and slip that the power required to pump the reduced flow was much more than would have been required to pump the greater quantity for which it had been designed, had it been operating under design conditions. Throttled down, the pump had an over-all efficiency of approximately 30 per cent. A new low lift installation designed for a discharge equal to that of the high lift pump, thereby eliminating the necessity for throttling, gave on test, an over-all efficiency of approximately 60 per cent.

Another city had been computing its pumpage on a false pump rating, a rating in fact about double the pump's actual capacity. This pump rating was so much in error that, had it been correct, the installation would have had a wire to water efficiency in excess of 100 per cent. And the secret of perpetual motion would at last have been found.

These cases are called to your attention in order to emphasize the necessity for the services of a reputable engineer when this type of installation is contemplated. With the decreasing cost of electricity, this installation is becoming increasingly popular. The efficiency of electrical units should be closedly watched. The greater efficiency being obtained from modern units will often be sufficient to warrant the installation of new equipment.

The speaker recalls one instance

where the replacement of an old installation having an over-all efficiency of 57 per cent with a modern unit having an over-all efficiency of 72 per cent decreased each monthly power bill an amount equal to 5 per cent of the total cost of the new installation.

Then there was the centrifugal pump whose 10-in. discharge line was reduced to 6 in. for a few lengths of pipe. The explanation given for this novel procedure was that the water pressure would be increased after going through the smaller pipe. This reasoning sounds strange to us today, but one of our engineers, delving through the council records of a city where he was working, found a case equally interesting.

When Hydraulic Knowledge Was Limited.—Some sixty years ago when our knowledge of hydraulics was not as extensive as it is today, an engineer had been employed to design a main between the reservoir and the city. This main was partly 20 in. and partly 18 in., fed by a 12 in. from the reservoir. The engineer in charge of the work was the author of the following interesting explanation:

This main line of pipe was enlarged by the direction of the Committee on Water under the light head at the Westerly end, to render the same much more effective as a means of conveying and delivering water at the extreme end of the pipe here in the city. Since the lighter the head, the larger is the required diameter of the pipes necessary to furnish the amount of water conveyed by the small pipe under a much greater increase of head; this change has been one of much utility in increasing the efficiency of this supply main.

Within ten years after the main was put in service, the supply in the city became so deficient that the main was not full at all times. The report of the Water Committee says:

While the discussion was going on about the High Service, the Engineer discovered that the main pipe already laid was wrong end first, and that the advantages of having a small pipe near the reservoir to fill and supply a larger one in the city, were not so great as he at first supposed.

These are only a small part of the interesting conditions found in our 30 years' work.

Acknowledgment.—The foregoing is a paper presented at the last annual meeting of the Central States Section of the American Water Works Association.

Master Regional Plan for Philadelphia.—A purse of $500,000 has been raised by the Regional Planning Federation of Philadelphia to be spent in the next five years in the development of a master regional plan for the city and its environs.

Snow Removal in a City of 25,000

Beloit, Wis., Disposes of Snow Through Storm Sewers

By C. O. RICKSECKER
Superintendent of Streets

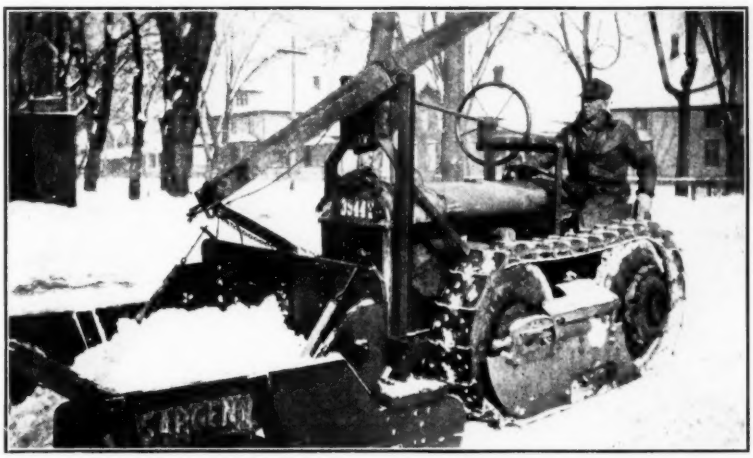
THE present administration of the city of Beliot, Wis., believes that it pays to keep the roadways of the business section free from snow and ice. Accordingly, city officials have carried out a policy of removing accumulated snow as rapidly as possible, and the most efficient methods of disposal have been sought to permit of securing the results desired.

Beloit is a city of about 25,000 population, having about 60 per cent of its roadways paved. The business section is divided by the Rock River, which conveniently allows large storm sewers to be brought under the downtown thoroughfares. A bridge with two trap doors over the river channel is centrally located. Thirty-three-inch manhole covers are placed on storm sewer manholes at favorable locations.

Disposal Through Manholes or Bridge Traps.—If a heavy snow is falling rapidly, it is plowed towards the curb to keep the roadway open until the storm is over. A motor patrol is then put on the streets to bring the snow back into the roadway in windrows not too large to handle. A truck or tractor then draws a snow scoop into the windrow of snow, where the scoop is loaded by one man. The loaded scoop is drawn to the nearest manhole or bridge trap and dumped as it is being drawn over the opening. The winter of 1928-29 was the first that motor power was used to draw the snow scoops.

If a snow is not falling too rapidly, the snow is plowed into windrows and moved away without first plowing towards the curb. A light snow may be moved from the curb into the roadway during the early morning hours, permitting automobiles to park normally while the snow removal is carried on during the day.

In disposing of snow through the storm sewer manhole, it is necessary to use a stream of water to carry the snow away. This is done by threading a fire hose through the storm water intake lateral and attaching it to a fire hydrant. This operation can be simplified by laying a small sewer pipe from the fire hydrant into the manhole at a time when new pavement is being laid; then only a short length of hose is needed to convey the water from the hydrant to the intake at the near end of the small pipe.



Motorized Equipment Keeps 80 Miles of Streets in Beloit, Wis., Open for Traffic During the Winter Months

Equipment.—One or two motor-powered road graders are used for keeping the snow in windrows. From four to six snow scoops drawn by one-ton trucks or Fordson tractors are sufficient if the haul is limited to two city blocks. The snow scoop used is the old-fashioned wooden scraper that has been in use for many years by ice harvesters—usually drawn by teams of horses. We are finding these wooden scoops rather light to be drawn by motor power and feel that there is room for improvement in this equipment.

In the residental sections, Beloit uses motor trucks fitted with mouldboard type snow plows. At this time the city owns two 5-ton street flushers that are snow-plow equipped in winter. An arrangement is made with a local contractor whereby the city furnishes the snow plows to equip his two 5-ton Mack trucks, thus making available four snow plows that are kept on the move during a storm to keep about 80 miles of streets open for traffic.

Adjustable Vanes on Turbine Runners.—Turbine runners at the Chippewa Falls plant of the Northern States Power Company in Wisconsin are equipped with adjustable vanes, the angle of which can be adapted to meet varying water conditions.

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Should Engineers Study the "Humanities"?

At the recent dedication of Dabney Hall, "the hall of humanities," at the California Institute of Technology, Dr. William B. Munroe said: "There is no good reason why engineers should be more limited in their intellectual versatility or in the range of their human interests than men in any other profession.

"These (humanity) courses cover the field of English and foreign literature, history, philosophy and social ethics, economics and government. No man can master science if he sets out to master science only. The history of human achievement has but a single page."

While we are believers in the thorough teaching of English and economics in all engineering colleges, we question the inclusion of the other subjects mentioned by Dr. Munroe, and we question even more seriously his whole attitude toward science.

Philosophy? What is it all about? The editor has studied at least three dozen books on the subject, and with the exception of those by Herbert Spencer, they constitute, for the most part, a very peculiar melange. In a recent editorial article entitled "Is Philosophy a Branch of Science?" we expressed the opinion that philosophy is a mixture of ultra-science (and therefore no science), metaphysics, morality and religion. We used Durant's "Story of Philosophy," and his definition, or rather description, of philosophy, to illustrate our meaning. He virtually admits the impossibility of defining philosophy, and by that very admission indicates the confusion that pervades that alleged realm of knowledge. Durant says: "Science gives us knowledge, but only philosophy can give us wisdom." This sounds erudite enough, but it is marrow of the very bone of nonsense.

The typical professional "philosopher" is a pathetic creature. He often starts by attempting to fathom the unfathomable. Failing, he still has the temerity to say that science lacks wisdom. We have been unable to find a single great discovery of any "philosopher" that has stood the test of time. Of course, many a truth has been uttered by "philosophers," but they were old truths and usually among the most obvious. Spencer came nearer to discovery of a great truth than any of them. But Spencer's philosophy is primarily a broad treatment of one scientific principle which he did not discover, namely, evolution.

Of all the subjects classed among the "humanities," history teaches the least, if you read it as it is taught. History falls even below philosophy in utility, for philosophy may at least set you thinking.

A teacher of history once asked an engineer whether he would not be ashamed not to know the main events of world history. The engineer replied by asking the teacher what causes typhoid fever; and received an admission of ignorance. Then the engineer asked: Which is most worth knowing; the campaigns of Caesar, or how to eliminate typhoid fever?

Typhoid at that time was one of our greatest scourges. Now it has practically vanished in America. Nothing but ignorance has so long delayed its banishment as a disease, but that was a kind of ignorance of which the typical teacher of history was not ashamed. He prided himself on knowing the chronology of kingly events and wars, but he took no pride in knowing how to reduce the death rate in his own town.

Still, it may be argued that when an engineer associates with "cultured" men, he must feel beneath their level if he can not talk about belles-lettres, history and the like. Any such argument shows that the proponent of "the humanities" little understands the culture of science. Was ever a true scientist abashed in making a confession of ignorance? Quite the contrary, for he knows that the all that any man knows is but the filmsiest gossamer beside the vast bulk of the unknown.

Men learn things, (1) for utility, (2) for the mere pleasure of learning, and (3) to secure the admiration that the learned are supposed to inspire; often the last named motive ranks highest. To be able to talk a learned jargon about art, about literature, about the Rome that was before her fall—such is the object of many a man, or at least it used to be a very common object a generation or two ago, when, as Spencer said: "Men dress their children's minds as they dress their bodies, in the prevailing fashion."

William Allen White, one of the speakers at the dedication of Dabney Hall, spoke of the advantage that "Cal. Tech." enjoys by reason of its proximity to "the store of research material at the Huntington library." That "store of research material" is mythical, we believe, in so far as utility is concerned; for it consists mainly of early editions and manuscripts of works that have no great value save that that springs from rarity. Like an indefatigable collector of postage stamps, the late Henry Huntington gathered into this library an amazing mass of literary junk. Grant that many an idle eye may gleam with passing interest over a manuscript poem of Burns or of Poe, and that many a tongue will tell how its possessor saw the first Guttenberg Bible in the Huntington library. There is just as much true worth, and not a tittle more, in such displays as there is in any other collection of antiques that give a thrill to the beholder. We do not deny the desirability of such thrills. We have often enjoyed wandering through such exhibits, and have gladly paid much money to reach them. The point we now wish to make is that the Huntington Library is infinitely less needed by the students and the teachers who work so near its portals than is a great scientific library, comparable, say, with the John Crerar Library of Chicago. The present library of "Cal. Tech." is almost an Eliot 5-ft. bookshelf compared with such a library as such a technical college should have.

Huntington followed his hobby of collecting objects of art and literature, and he poured millions into it. Yet within a rifle-shot and unobserved, there was springing up an institution of scientific culture destined

to make all his collections look as insignificant as the store of nuts gathered by a squirrel.

Huntington apparently had no conception of science, of its beauty and its power, of its culture and its grace, of its research devotees whose imagination outsoars that of the poets.

Einstein working in a garret, locked away from intrusion behind his iron door, was ten years dreaming a greater dream than can be found in all the tomes and manuscripts of the Huntington Library. But it will take more than a generation yet, we fear, before many of our men of great wealth will endow libraries for the use of the scientific dreamers who make their dreams come true. Theirs are the dreams that have lifted humanity above the level of a bestial struggle for existence; for upon an understanding of nature and her laws rests all of engineering and all of that great branch of engineering called invention.

Whenever an advocate of "the humanities" insists that engineering colleges should teach all the so-called "humanities," we rise to demur. With much better array of evidence might we argue that the sciences be given precedence in the courses that lead to an A. B. degree. But the truth is that it is futile to try to be jack-of-all-trades. After graduation many an engineer has beguiled his leisure hours reading history and literature of all sorts, and has puckered his brows over philosophies. Perhaps it has taken the typical engineer many a perplexed moon before it began to dawn upon him that his inability to see to the bottom of these philosophic wells lies not in the profundity of the depth into which he peers, but in the roiled and muddy water with which these wells are filled. If so, that type of reading is ill suited for an undergraduate, be he scientific or be he classical.

After all, a truly cultural course of study is one that trains a youth to become a systematic searcher for information and a good analyst of the significance of facts. When this is made the aim of formal education, less will be heard as to which particular class of facts should be studied. Even history might yield a splendid training in science if taught as research science is taught.

"The Padre of the Rains"

In a quiet little California town; and within the still more quiet confines of the walls of a Catholic university, lives a man whose research work is destined to rank with that of a brother Jesuit, long dead yet but recently become famous. The living man is Father Jerome S. Ricard, "the padre of the rains." The dead man is Gregor Mendel, great discoverer of the law of heredity that bears his name.

A few months ago the editor had the pleasure of interviewing Father Ricard in Santa Clara, and of hearing from his lips an account of his methods of weather forecasting. Since his methods have been described in this magazine, they need not be repeated now further than to say that Father Ricard bases his predictions upon the barometric effects of sunspots. At the first of each month he publishes his predictions for the following 30 days, covering only the weather of the Pacific Coast region.

Each sunspot in the sun's northern hemisphere tends to produce air-whirls on the earth, and if the spot is sufficiently powerful the resulting air-whirls develop into cyclonic storms. Solar rotation brings the same spot around every 27.28 days, as long as the spot "lives," and it is this fact that enables Father Ricard to predict the arrival of barometric "lows" on the Pacific Coast with such accuracy. Whether a rain storm will result from a "low," and exactly what the track of the storm will be, are matters not so certainly predictable; but from interviews with several persons who have kept records of the predictions and the results, it was found that Father Ricard's forecasts have been remarkably correct. Father Ricard said: "Sunspots do for the weather what the moon does for the tides and do it more visibly and more accurately."

Scientists have been so skeptical of the effect of sunspots on weather that they have seldom investigated thoroughly the evidence of that cause-effect relation. And where investigation has been made, it has usually resulted in doubt, because of the seeming complexity of the whole matter. But complexity is often more apparent than real, as the history of science repeatedly shows. Let even one important fact be unknown, and lack of knowledge of that fact may so obscure the entire phenomenon as to give an appearance of great complexity. One of the facts that has been insufficiently attended to, even when it was known (which was seldom), is the fact that sunspots in the sun's northern hemisphere produce exactly the opposite effect on our atmosphere that is produced by spots in the sun's southern hemisphere. Also there should be considered the fact that at about the middle of every 11.2-year sunspot cycle, the new sunspots have a rotation the reverse of that of the old sunspots, and consequently a changed magnetic polarity. In addition to these differences and changes, there is another factor that has received scant attention, namely, the periodic shifting of the latitude of storm tracks. The editor has found that there are 12 giant air whirl-belts, three of which have centers on the arctic circle; and that the cyclonic storms that come out of the north start in these whirl-belts, and travel in parabolic paths southeastwardly. When these giant whirl-belts expand, as they do when sunspots grow more numerous, the cyclonic storms originate in lower latitudes; but, tending to offset that, is the fact that the parabolic path flattens so that the storm center hugs closer to the giant whirl-belt. This usually causes a northward migration of the storm belts, a fact that had been previously discovered, but not explained, by Kullmer.

In one sense the whole problem of storms is complex; in another sense it is not. There are, it is true, several forces to be considered, and that gives it such complexity as it has. But, there is, the editor believes, only one kind of force, namely, electricity, that produces the major effects; and that fact gives to the weather problem a degree of simplicity not hitherto recognized. At any rate, this electrical "key" has already unlocked several doors of meteorological mystery and has made simple what before seemed complex.

In honor of Father Ricard's achievements, the Father Ricard Memorial Observatory has just been built at the University of Santa Clara, where he has taught astronomy and mathematics for many years. The observatory has a 60-in. reflecting telescope. Equipped with this new engine of research, greater knowledge of the relation of sunspots to weather will doubtless be made by "the padre of the rains" and his assistants. But we venture to say that the greatest engine of research in that observatory will continue to be the brain of the man to whom the observatory has been dedicated.

H. P. Gillette

New Books

"Memoirs and Addresses of Two Decades," by J. A. L. Waddell, Consulting Engineer. First edition, 1174 pages, 6 in. by 9 in., hard cover, cloth binding; Mack Printing Company, Easton, Pa., publishers. Edited by Frank W. Skinner, Consulting Engineer. Price, $5.00.

The material in this book is divided into eleven groups as follows:

1—The Engineer Profession, 2—Ethics of Engineering, 3—Technical Education, 4—Engineering Literature, 5—Alloy Steels for Bridge Construction, 6—Economics, 7—Bridge Construction in General, 8—Contracts, 9—Railroad Subjects, 10—Matters Chinese, 11—Miscellaneous Topics.

The great variety of subjects covered by Dr. Waddell during the last 22 years precludes any possibility of confining the material to one subject. It thus becomes necessary to classify his writings in a general way.

It is an outstanding characteristic of Dr. Waddell's professional work to reduce his thoughts to writing after he has completed some particular investigation or project. It is indelibly written upon his mind that transmission of knowledge, ideas and intelligence is one of the greatest forces promoting the advancement not only of our profession, but of the civilized world in general. He, therefore, responded to an irresistible inner urge that took the aspect of a duty, throughout his professional career to open his thoughts and results to the glare of public scrutiny and searching professional sifting.

This book is a compilation of the results of that urge. It should be very suggestive and helpful to all engineers who expect to design or construct important work. The civil engineer in general practice will find in the different pages presented here a broad and practical system; a code of high professional standards; a guide to fundamental technical education; and the epitome of bridge-design essentials which is today the highest standard for advanced construction and practical economics, and which furnishes data for the rational tests, estimates, and comparisons of different important designs.

"The Profession of Engineering," edited by D. C. Jackson, Jr., S. M., Professor of Mechanical and Electrical Engineering, University of Louisville, and W. P. Jones, Ph. D., Assistant Professor of English, University of Louisville. First edition, 124 pages, 5 in. by 7½ in., flexible binding; John Wiley & Sons, Inc., New York, publishers. Price, $1.50.

The articles in this volume, though written by several different men, were selected and arranged to form a unified whole. They give a broad, non-technical, yet detailed conception of the profession of engineering. The following articles are included: The Engineer and His Education, Success in the Engineering Profession, Civil Engineering, Mechanical Engineering, Mining Engineering, Electrical Engineering, The Electrical Engineer, The Chemical Engineer, The Engineer's Contribution to Modern Life.

"Sewerage and Sewage Treatment," by Harold E. Babbitt, M. S., Professor of Sanitary Engineering, University of Illinois, Member American Society of Civil Engineers. Third edition, 545 pages, 6 in. by 9 in., hard cover, cloth binding; John Wiley and Sons, Inc., New York City, publishers. Price, $5.00.

The continued advance through which the art of sewage treatment is progressing made necessary the revision and enlargement of this book. New additions to this text discuss information on the mechanical aeration of activated sludge, on gas collection from sludge digestion tanks, and on separate sludge digestion. In the first part of the book minor revisions have included simplification of methods of computation as in the design of an inverted siphon; correction of numerical solution of illustrative problems; and bring other information up to date.

The book is profusely illustrated and doubtful points clarified by picture or table. It is written more for the purpose of explaining fundamentals than of comparing various methods. The quotation of expert opinions which may be in controversy or the citation of examples of different methods of accomplishing the same thing has been avoided when possible in order to simplify explanations and to avoid confusing the beginner.

"Suspension Bridges," by D. B. Steinman, A. M. C. E., Ph. D., Consulting Engineer, etc. Second edition, 299 pages, 5¾ in. by 9 in., hard cover, cloth binding. John Wiley and Sons, Inc., New York, publishers. Price, $5.00 net.

During the past few years there have been new developments in the art of suspension bridge design and erection. Among the portions of this book that have been rewritten or amplified are those bearing on the topics of wire cables vs. eye-bars, rocker towers, anchorage design, materials used in suspension bridges, economics and limiting proportions, comments on the deflection theory, formulas for temperature stresses, multiple span bridges, proportioning cable bands, calculation of cable diameter, and time records of erection.

Appendix D, on the deflection theory, is perhaps the most important contribution to this new edition.

Appendix E presents an interesting chronological table of suspension bridges.

"The New Technique of Uncovering Security Bargains," by John Durand. First edition, 203 pages, 5 in. by 7¼ in., flexible binding. The Ticker Publishing Co., New York City, publishers.

This volume is intended to meet the requirements of month-to-month investors, where methods of operation occupy a middle ground between deductions from the technical position to which week-to-week traders look for guidance, and studies of values of fundamentals which are the chief reliance of year-to-year investors. The Group Ratio Curve, a tool developed for this purpose, is explained in this volume.

"Sewerage," by A. Prescott Folwell, Sc. D., Member American Society of Civil Engineers, Past President American Society for Municipal Improvements, Editor of Public Works. Tenth edition, rewritten and reset, 399 pages, 6 in. by 9 in., hard cover, cloth binding; John Wiley and Sons, Inc., New York, publishers. Price, $4.50 net.

Research and experiment, statistical analyses with records and operating experience, investigation and new equipment are some of the causes producing improvements and changes in not only the sewerage field but in all fields. This book has been rewritten to cover improvements and changes in the methods of handling sewerage. Progress in methods of sewerage disposal are largely responsible for the production of this book.

As in older editions, Part I concerns sewerage systems and Part II deals with sewage disposal. Beginnings have been made of thorough scientific studies of the biological, chemical, and physical phases of sewage treatment, with special attention to sludge digestion. A number of activated sludge plants have been built. More definite knowledge has been acquired concerning the effects of dilution and the principles involved therein. Inventions of machinery and equipment for treatment plants have come into extensive use. These are the primary causes for this revision.

The book is quite well illustrated.

"Mathematical Tables and Formulas," by Percy F. Smith, Ph. D. and William R. Longley, Ph. D., professors of mathematics in Yale University. First edition, 66 pages, 5¼ in. by 7¾ in., flexible binding; John Wiley and Sons, Inc., New York, publishers. Price, $1.60.

This collection of tables and formulas can be used handily for solving numerical problems of mathematical nature. They are only as accurate as the authors deemed commensurate with that required for practical work. Four figure accuracy was considered usually sufficient. The book should prove of some assistance to students in connection with college courses in trigonometry, analytic geometry, calculus, and mechanics.

"American Sewerage Practice, Volume 1, Design of Sewers," by Leonard Metcalf and Harrison P. Eddy, consulting engineers, Boston, Mass. Second edition, 759 pages, 6 in. by 9 in., hard cover, cloth binding; McGraw-Hill Book Co., Inc., New York, publishers. Price, $7.00.

This volume is primarily a reference book. It is the first of a series of three books by the same authors. American practice in sewer design has attained a certain degree of uniformity and considerable advance has been made in the methods of application of principles in recent years.

Table of contents:

The Lessons Taught by Early Sewerage Works; The General Arrangement of Sewerage Systems; Hydraulics—Flow of Water and Sewage; Velocities and Grades; Measurement of Flowing Water; Quantity of Sewage; Separate Sewers; Precipitation; Storm Water Runoff; Storm Drains and Combined Sewers; Gaging Storm Water Flow in Sewers; Sewer Pipe; Masonry Sewers; Loads on Sewers; The Analysis of Stresses in Sewer Sections; Inlets, Catch Basins and Manholes; Junctions, Siphons, Bridges, and Flushing Devices; Regulators, Overflows, Outlets, Tide Gates, and Ventilation; Pumps and Pumping Stations.

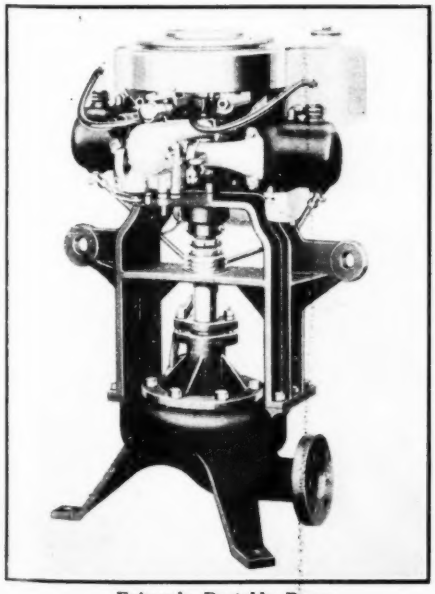
Evinrude Announces New Twin Centrifugal Pump

The new Evinrude pump, incorporating the features of portability, low cost operation, and large capacity, fills a definite need for contractors confronted with the problem of moving excess water from ditches and trenches, supplying pavers and mixers with water, and other everyday jobs. In commercial water transportation, this pump becomes very effective when awkward quarters, too small to handle a large diaphragm or bilge pump, often present a problem of excess water disposal. Dredging companies and barge lines are finding that the Evinrude centrifugal pump is a solution to their problem, for the outfit is portable and requires little space. When the Evinrude centrifugal is used, it is not necessary to start the motor merely to remove a small quantity of water.

This new improved centrifugal is powered by the Evinrude 6-hp. "Fleetwin" motor, a modern twin engine. Manufacturing precision is used in machining, and by carefully weighing and balancing all moving parts, a power plant which is practically vibrationless has been achieved. At the same time, the new pump has been decreased in weight to slightly over 100 lb., making the outfit truly portable and vastly increasing its field of usefulness.

Notwithstanding the fact that the pump is no larger than a small keg of nails, it is capable of pumping 15,000 gal. of water an hour and reaches a head of 50 ft. with ease, the manufacturer claims. The operating cost is negligible, not exceeding 15 ct. per hour, or 1 ct. per 1,000 gal., they state.

The pump itself has but one moving part, the bronze impeller, directly splined to the alloy steel shaft. When revolved, the flukes or vanes of the impeller throw the water outward with a great force and cause it to flow through the discharge pipe. The motor is fitted with the Evinrude magneto of the built-in flywheel type. The flywheel itself acts as an umbrella-like protection over the magneto, shielding it from rain, spray and dirt. Waterproof cables connect to the spark plugs. The Evinrude carburetor brings the advantage of automobile carburetion; a float-feed carburetor which works in any position. With capacity more than doubled over last year, and with the weight decreased 10 per cent, and over all size 11 per cent, the new Evinrude twin-cylinder vibrationless centrifugal pump makes a noteworthy addition to the portable pump field.



Evinrude Portable Pump

Long Handled Meter Key

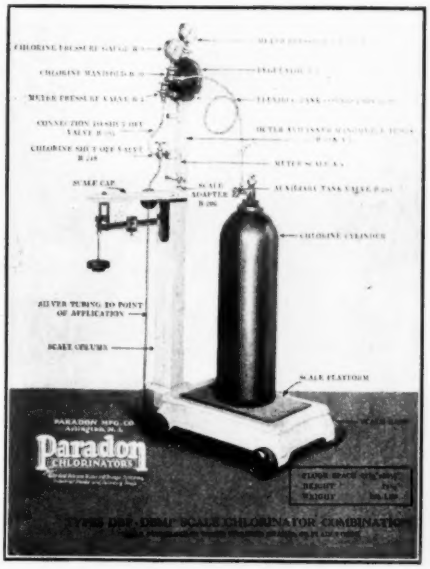
The H. W. Clark Company of Mattoon, Ill., have placed on the market a long handled key for operating their meter boxes. The box has been in production only a short time. It is 16 in. in diameter and 16 in. deep, with a full 12-in. lid opening. The lid is equipped with a rustproof lock, which is operated by the long handled key. A lug on the side of the key may be used to flip back the lid of the meter. The end is provided with a chisel point for scraping.

New Meter Box and Key

A New Combination Chlorinating Scales

The Parodon Manufacturing Co., Arlington, N. J., announces a combination chlorinator-platform scales, known as Model DBP chlorinating scales.

The complete chlorinator is directly mounted on a standard platform scales. The unit is designed so that all parts of the combined chlorinator-scales are interchangeable with the parts of the regular chlorinator without the scale mounting so that existing chlorinator installations may readily be converted to the new chlorinating scale type.



Paradon Scale Chlorinator Combination

The use of a platform scales in connection with a chlorinating installation has practically become standard practice among engineers and sanitarians.

Advantages claimed for the new chlorinating scales are that it saves considerable floor space, makes a neat and more attractive installation than where scales and chlorinator are separate, and that it insures the scales always being available for use with the chlorinator, and not for other uses about the plant.

The cost of the new chlorinating scales, using a standard platform scales, is no more than the cost of the chlorinator and scales separate.

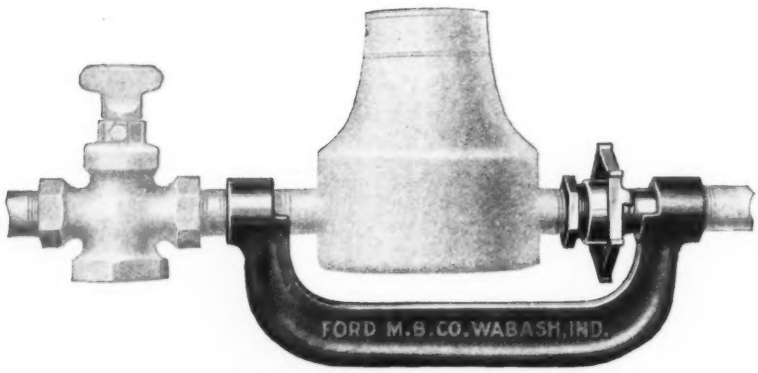
The combination is adaptable to all standard Paradon chlorinators—both solution feed and direct feed types—and for any chlorine capacity.

For further information write to Mr. R. V. Donnelly, Paradon Manufacturing Co., Arlington, N. J.

New Meter Box Yoke Developed

The Ford Meter Box Co., Wabash, Ind., has recently developed a new type of meter box yoke. They have called this new yoke the Straight Line yoke. It is intended primarily for water meter installations where the pipe and meter are set in a straight line through the meter box. Such settings are standard practice in the south and west, where the climate is mild and surface lines shallow. It is also well adapted for basement installations.

A water meter set in such a line with



New Ford Straight Line Yoke for Water Meters

ordinary couplings is very difficult in removal and replacement, as the gasket space is nearly always wrong, and the coupling nuts can hardly stretch the pipe to pull the coupling barrel tight against the meter gasket.

The Ford Straight Line yoke simply provides a strong spacer piece, or yoke, which becomes part of the straight run of pipe, and also provides an expansion connection which screws onto the meter and then expands outward against the gaskets in the yoke saddles to make tight joints. To remove the meter, the connection is contracted and the meter lifted out. The pipes never move and the spacing and alignment are permanently fixed.

The Straight Line yoke costs but little more than the couplings and fittings it replaces, and it gives many advantages. It is made with or without a union for old or new services, and for ⅝-in., ¾-in. and 1-in. meters.

More details may be obtained from Mr. John L. Ford, Ford Meter Box Co., Wabash, Ind.

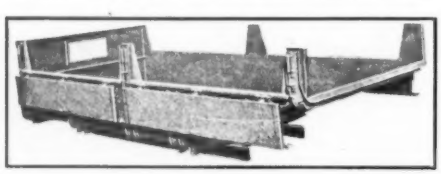
New Garbage Hauling Truck Body

The Wood Hydraulic Hoist & Body Company recently produced new special dump bodies for garbage collection to be used by the city of New York.

The type W-34 special garbage body has sliding steel covers—in four sections, with manually-operated tailgate. It is constructed of high carbon, blue annealed sheet steel—hot riveted and electrically welded for water tightness. Rear end is tapered 20 deg. to allow contents to flow freely when dumping.

The type W-36 is similar to the type W-34, except that it has hinged extension sideboards with patent tailgate which hinges underneath body when dumping, but no steel covers. Tarpaulin covers may be used.

Further information about these garbage bodies may be obtained from the manufacturer.



W-36 Body—Tailgate Hinged Underneath Body and Sides Hinged Downward for Easy Loading

Koehring Pull Shovel Announced

The Koehring heavy duty pull shovel is the latest unit added to the line of excavating equipment manufactured by the Koehring Co., Milwaukee, Wis.

The outstanding features are (1) the shock absorbing principle in the boom base and in the dipper stick and (2) a specially designed jib frame providing a greatly increased working range and flexibility of operation.

The boom shock absorber is identical with that used on the Koehring shovel and in the same manner takes the twisting strains out of the boom and cushions the dipper when trimming the sides of a sewer trench.

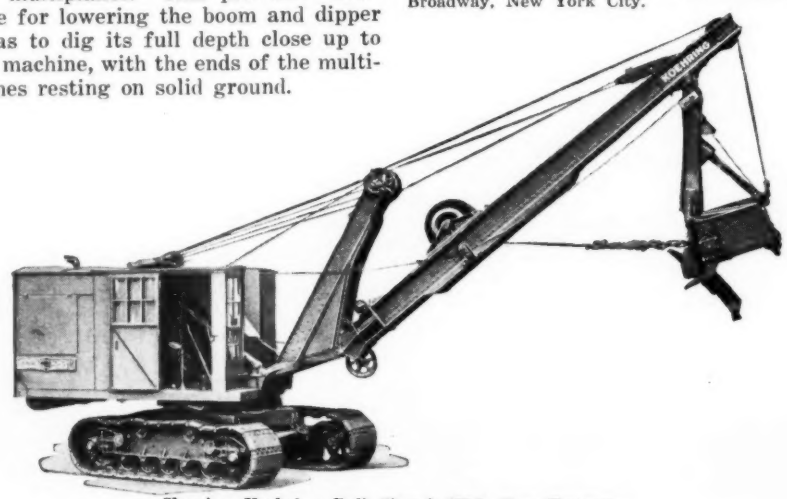
The dipper stick unit adds power to the digging effort by producing a gnawing action in hard, tough digging through the action of the powerful shock absorbing spring upon the dipper.

Instead of being hinged to the turntable casting, the boom is hinged to a separate casting which forms the base of the jib frame. The hinge point on all machines is 6 in. beyond the end of the multiplanes. This provides clearance for lowering the boom and dipper so as to dig its full depth close up to the machine, with the ends of the multiplanes resting on solid ground.

This hinge point can be raised to a working position from 1 ft. 9 in. to 2 ft. above the turntable hinge pin sockets, giving a high dumping clearance. Or, the hinge point may be lowered below the level of the turntable sockets to provide a maximum digging depth.

This construction of the jib frame gives the Koehring flexibility and variation of working range in all operations.

The Koehring pull shovel is built in two sizes, equipped with ⅞ and 1¼ cu. yd. dippers. Digging depths range from 17 ft. to 24 ft.



Showing Koehring Pull Shovel With New Features

Q-Check Distinctive Trade Mark

The symbol shown in the accompanying figure has been adopted as the trade mark of the Cast Iron Pipe Research Association. Cast iron pipe which has benefited through improvements which scientific research has introduced, can hereafter be identified by this symbol. It will appear on cast iron pipe made by the following pipe founders:

The Cast Iron Pipe Research Association's Trade Mark

American Cast Iron Pipe Co., Birmingham, Ala.; James B. Clow & Sons, 219 N. Talman Ave., Chicago, Ill.; Donaldson Iron Company, Emaus, Pa.; Glamorgan Pipe & Foundry Co., Lynchburg, Va.; Lynchburg Foundry Company, Lynchburg, Va.; National Cast Iron Pipe Company, Birmingham, Ala.; United States Cast Iron Pipe & Foundry Company, Burlington, N. J.; Warren Foundry and Pipe Company, 11 Broadway, New York City.

ADVANTAGES OF PERMANENT PLANT FOR CONCRETE PIPE MANUFACTURE

No. 5 of Technical Series

Atlantic Cement Products, Inc.
Hicksville, Long Island, N. Y.

Improvement in quality will lead to increased use of concrete pipe

No loss of time because of bad weather will result in lower manufacturing costs with steady employment of labor and equipment. Accurate forecasts of production can be made. Being protected, equipment lasts longer. When under shelter and provided with comfortable and familiar conditions, workmen produce more. The smaller turn-over in labor favorably affects production.

With activities concentrated, closer supervision results. The superintendent can watch every step in the process of manufacture and prevent mistakes.

The Purchaser and his Engineer should satisfy themselves that the Pipe Manufacturer has modern equipment; employs modern methods; has proper facilities for making tests; and that an Inspector will easily be able to see what he should. The Manufacturer who has a modern permanent plant with easy access for inspection of process and product is naturally favored by Engineer and Purchaser.

The permanent concrete pipe plant produces a uniform product. It can run summer and winter—day and night if need be—and the product will not suffer in quality. The stock can be built up prior to heavy spring demand.

Discriminating Purchasers are paying more for centrifugally made concrete pipe. A fair investigation will prove the superiority of the

MOIR-BUCHANAN Centrifugal Process

For information concerning this process write to—

ASPHALTO-CONCRETE CORPORATION

1440 Broadway, New York City

DISTRIBUTOR NEWS

The Distributor's Department in the Gillette Construction Group

SOS

This department is conducted by Station GCG (The Gillette Construction Group), but we need your help and cooperation. The more stories and items you send in to us, the more interesting will this section of our papers be to all our readers. Let us hear from you. Address The Editor, Distributor News, Gillette Publishing Company, 221 East 20th Street, Chicago.

Distributor Advertising Service Announced by Petroleum Heat and Power Company

An intensive advertising campaign has been planned by the Petroleum Heat & Power Co. of Stamford, Conn., to include newspapers, general and trade magazines, direct mail campaign, billboard and other features, which they expect to tie up directly with their distributors and dealers by means of a publicity service bureau.

The organization of this advertising and publicity service bureau for the benefit of the distributor is in the hands of Mr. J. R. Lunstead, formerly associated with the Radio Corporation of America. This direct tieup of the dealers' local advertising with national advertisements is an indication of the importance of the distributor in the sales promotional work.

There will be available for distributors and dealers, seasonal tie-up in newspaper ads for which either electros or complete matrices will be furnished, reprints of national advertisements, etc. This material will be distributed by the new service bureau, and the distributors will be informed on the latest methods of preparing and placing their local advertising, and in securing the best results from their efforts. The dealer is offered the personel service of the publicity bureau staff.

Feenaughty Machinery Represents Galion in Oregon, Washington and Idaho

Feenaughty Machinery Company, which was appointed several months ago as distributors in Oregon for the Galion Iron Works & Manufacturing Company, has now been given the Washington and Idaho territory as well. This announcement was made by the Pacific Coast representative of the Galion Company, Mr. Y. T. Leftwich. This change was made when the Jeffrey Manufacturing Company acquired control of the common stock of the Galion concern.

Butler Bin Make Several New Appointments

Fourteen new distributors have been appointed to handle the products of the Butler Bin Company of Waukesha, Wis., manufacturers of steel storage bins, weighing and measuring hoppers, bin gates, etc. The new representatives are: Arizona Road Machinery Co., Phoenix, Ariz.; General Equipment Mach. Co., Miami, Fla.; Hofius-Ferris Equip. Co., Spokane, Wash.; J. B. Harbison Equip. Co., Little Rock, Ark.; Loggers & Contractors Equip. Co., Portland, Ore.; Mechanical Supplies Co., Cincinnati, O.; W. T. McDonald & Co., Indianapolis, Ind.; New Mexico Road Machinery Co., Albuquerque, N. M.; Stannard-Arnold Co., Salt Lake City,

Annual Banquet of Associated General Contractors of America. Held at the Hotel Sherman, Chicago, Feb. 21, 1929

Suddenly, out of a spring sky . . .

An Advertisement of the
American Telephone and Telegraph Company

ALL was well on the telephone front on April 27, 1928. Suddenly, out of a spring sky, rain began to fall over central Pennsylvania. As night came on this turned into a furious storm of sleet, snow and wind. Inside of 48 hours, 3700 telephone poles were down. Seven thousand miles of wire tangled wreckage. Thirty-nine exchanges isolated. Eleven thousand telephones silent.

Repair crews were instantly mobilized and sent to the scene. From Philadelphia 47 crews came. Other parts of Pennsylvania sent 13. New Jersey, 6. New York, 4. Ohio, 6. Maryland and West Virginia, 12. In record time, 1000 men were stringing insulated wire and temporary cables along the highways, on fences and on the ground.

Within 72 hours the isolated exchanges were connected and the 11,000 telephones back in service. Then, while the temporary construction carried on, neighboring Bell System warehouses poured out all needed equipment, new poles were set, new crossarms placed and new wire and cable run.

In any crisis there are no state lines in the Bell System. In all emergencies of flood or storm, as well as in the daily tasks of extending and maintaining the nation-wide network, is seen the wisdom of One Policy, One System, Universal Service. Better and better telephone service at the lowest cost is the goal of the Bell System. Present improvements constantly going into effect are but the foundation for the greater service of the future.

"THE TELEPHONE BOOKS ARE THE DIRECTORY OF THE NATION"

Utah; J. C. Sheehan & Co., El Paso, Tex.; Tri-State Equipment Co., Memphis, Tenn.; Taylor Tractor Co., Columbus, O.; Geo. V. Treen & Co., Charleston, W. Va.; Wiley Bros., Inc., Oklahoma City, Okla.

Link-Belt Elects Watson Vice-President

James S. Watson, a Philadelphia youth thirty-four years ago, entered the local plant of the Link-Belt Company. Announcement has just been made of his election to the vice-presidency of the company. His headquarters will be at the Dodge works in Indianapolis.

After Mr. Watson had been with the company about eight years, gaining experience in various departments, he was chosen to take charge of the exploita-

James S. Watson

tion of Link-Belt silent chain as a power transmitting medium. This was in January, 1903, when silent chain was new, having been introduced in 1900. Since then Mr. Watson has become well known throughout the country as the head of the drive chain division of his company.

For the past nine years he has been located at the company's Dodge Works in Indianapolis, where as general manager, he has been in charge of production and sales of Link-Belt silent and roller chain drives, as well as Herringbone speed reducers through a band of power transmission engineers located in all the principal cities.

With this item we present a picture of the outward and visible Mr. Watson, but for knowledge of the man himself, we quote his business ideals:

"A definite knowledge of one's product; faith in one's self; belief in one's business associates; respect for one's competitors; and a general adherence to the Golden Rule."

Portland Cement Association Appoints New Southwestern Manager

Mr. Charles A. Clark, formerly district engineer in Dallas, Texas, for the Portland Cement Association, has been appointed manager of the Southwestern offices of the company, with headquarters at Kansas City, according to announcement of Mr. William M. Kinney, general manager of the association.

Mr. Clark is an alumnus of the University of Missouri, and during the past twenty years has been associated with several important engineering projects. On the Florida East Coast Railway from mainland to Key West, he acted as concrete inspector, and later was active in the development of Illinois' model highway system.

In 1917, Mr. Clark joined the staff of the Portland Cement Association as a fieldman for Missouri and Oklahoma. After a period of administrative work in the Chicago general office, he was assigned to Dallas as district engineer. From his Kansas City office, he will have supervision over Texas, Oklahoma, Kansas, Nebraska and Western Missouri. Mr. Clark is to succeed Mr. Forest Kaufman, resigned.

Many New Distributors to Handle REX Equipment

The Chain Belt Company has just appointed fourteen new distributors in almost as many states, to handle their line of REX equipment, including mixers, pavers, pumps, saw rigs, plaster and mortar mixers. The recent appointments are: The G. C. Phillips Tractor Co., Birmingham, Ala.; McGowin-Lyons Hardware & Supply Co.; Mobile, Ala.; Burnite Machinery Company, Denver, Colo.; Fuchs Equipment Company, Omaha, Neb.; Gierke-Robinson Co., Davenport, Ia.; Sheehan & Company, El Paso, Tex.; The Arizona Road Machinery Co. (branch of Sheehan), Phoenix, Ariz.; The New Mexico Road Machinery Co. (branch of Sheehan), Albuquerque, N. M.; Youngstown Mill Supply Company, Youngstown, O.; The LaLance Equipment Co., Huntington, W. Va.; McNeilly Machinery Company, Columbus, O.; Earnest Brothers, Norfolk, Va.; The Clyde Company, New Orleans, La.; Stannard-Arnold Machinery Co., Salt Lake City, Utah.

Huebotter Joins Waukesha Engineering Staff

Mr. H. A. Huebotter, well known to automotive and Diesel engineers, has recently joined the technical staff of the Waukesha Motor Company, Waukesha, Wis. He comes to the Waukesha Motor Company from the Butler Manufacturing Company, Indianapolis, Ind., where he was chief engineer.

Mr. Huebotter has been engaged in both practical and theoretical research for a number of years. From the time of his graduation from Purdue University in 1912, he has devoted his energies to automotive research, design and production. Extensive opportunities for research were available to Mr. Huebotter, when for several years at Purdue, he conducted classroom instruction, and worked out various experimental problems.

He is a member of the Society of Automotive Engineers, and is the author of the book "Mechanics of the Gasoline Engine."

M. B. Rider Joins H. O. Penn Mach. Company

Mr. M. B. Rider, formerly New York sales manager for the T. L. Smith Company, has joined the H. O. Penn Machinery Company as sales manager of the road building equipment division. Mr. Rider is well known in the east because of his long experience with road building equipment and the construction industry in general.

The H. O. Penn Machinery Company represent a number of prominent manufacturers of construction equipment, and Mr. Rider will handle the sales of all road construction equipment. Among the manufacturers whose products he will sell are Chain Belt Company and Butler Bin Company.

Atlanta Branch Opened by J. D. Adams Company

A new branch office and warehouse has been opened in Atlanta by J. D. Adams Company to serve their Georgia trade.

For a number of years the Adams adjustable leaning wheel graders and other road equipment have been sold by distributors in Georgia. This equipment is now being sold and serviced by the Atlanta branch.

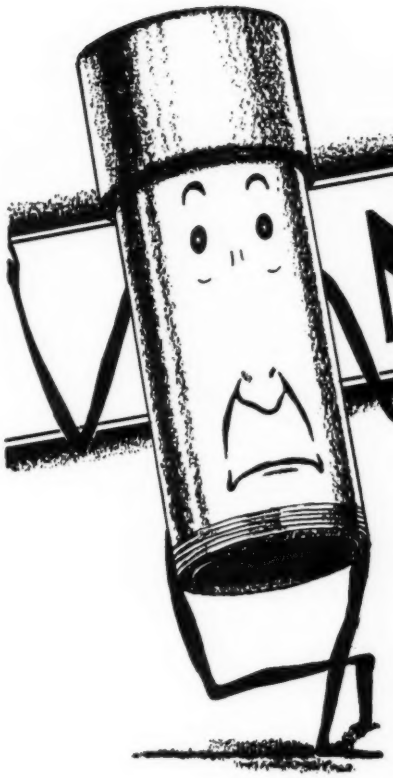
Business Outlook in Maryland Good

J. J. Smith, 3620 Ednor Road, Baltimore, recently appointed representative for the Chicago Pump Company, reports that the outlook for business in Maryland and the District of Columbia for lines handled by him is unusually good.

In addition to a complete line of electrically-driven pumping machinery, Mr. Smith handles cast iron boilers, steel boilers of high and low pressure, ventilating equipment and hot water storage heaters.

Recent Appointments

The Chicago Pump Company have recently added to their list of representatives the following: Mr. Bernhard E. Hovind, 326 Jay St., La Crosse, Wis., and S. T. Weaver Company, 1002 N. Clinch St., Knoxville, Tenn.



Not in the bag

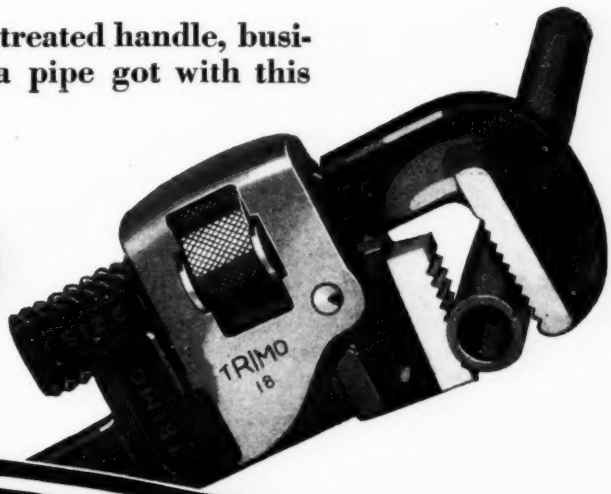
ANDREW J. PIPE emphatically denies the rumor that his recent disastrous contest with a Trimo pipe wrench was "in the bag."

"I know that I made a miserable showing, but I want all pipe lovers to know that I did my best.

"This new Trimo has a vicious grip and an ugly disposition. In fact it makes me feel a little shaky just to think about it."

The day when a stubborn pipe or nut could put up a winning fight is gone now. Trimo, Improved and Mightier, makes 'em all say "uncle."

Look over the rugged frame, heat treated handle, business-like jaws—what chance has a pipe got with this *all steel wrench?*



TRIMO

TRIMONT MFG. CO., INC.
ROXBURY (BOSTON), MASS.

IMPROVED *and* MIGHTIER

Pipe Wrench

SERVICE EXCHANGE
For
Manufacturers or Distributors

Editor's Note.—From time to time we receive letters from distributors wishing to be put in touch with manufacturers of certain lines of equipment, or from manufacturers seeking representatives for their products. Items of this kind will be published and names and addresses furnished interested persons upon request.

New Lines Wanted

Road machinery distributor would like to secure exclusive sales rights for state of Mississippi for line of automatic or self-loading wheeled scraper.

A Michigan distributor, with many years' experience, representing at this time prominent manufacturers of pumping machinery, offers the services of an established representative to manufacturers needing increased facilities in this region.

Manufacturers' representatives located in New York would like to add line of heavy contractors' equipment of established reputation, other than the lines now handled by them. They would like exclusive sales rights for such equipment.

New York company would like to represent manufacturers not already established in eastern market, or who would like to make a change in their sales arrangements.

Machinery company in the east is interested in representing established lines of road machinery, with the exception of graders.

A man of many years' experience in the machinery business in the south would like to make a business connection for the sale of road machinery equipment.

Eastern Distributor handling Brick and Clay Products, and similar commodities, would be pleased to get in touch with manufacturers desiring eastern representation.

Machinery distributor established in Porto Rico and Santo Domingo would be pleased to make arrangements to take on new lines in these territories.

Executive with 20 years' experience in selling contractors' and builders' machinery and equipment, is starting new organization and would like to hear from manufacturers desiring representation in Northern California.

A contractor's superintendent, located in Florida, would like to represent some road equipment manufacturers in his territory.

District respresentative for sanitary engineering specialties would be interested in any line in the water works field. Has had experience in field of filters, softeners and water meters.

Representatives Wanted

Manufacturer of hoisting machinery and air compressors has open territory in New York and New England states for aggressive distributor.

Manufacturer of two cycle oil and gas engines in sizes from 30 to 125 H. P. adaptable for water works and many industrial purposes, wishes to establish points of distribution throughout the country.

New York corporation wishes to establish agencies throughout the country, prefer men specializing in heating and ventilating equipment.

A manufacturer of paving expansion joints is looking for distributors for northern California territory.

New York corporation, producing complete line of coal-tar products, wishes to make dealer connections throughout the country.

Manufacturer of building specialties wishes to establish distributors throughout the country. Manufactures concrete reinforcements and metal lath; Reed clips, form spacers, continuous column tie, continuous chair stirrup, beam bar spacers, slab bar spacers, continuous Hi-chair, continuous anchor slot, sleeping spacing anchor, humpback hairpin clip, lath hanger, stone anchors, straight wire lengths and special wire lengths.

Manufacturer of threadless pipe couplings and tees, with rapidly growing business, is seeking additional representatives.

Manufacturer of metal tie and spacer wishes to establish distributing points throughout the country.

Manufacturer has some attractive territory available for distributors for complete line of generators, and centrifugal, diaphragm and piston pumps.

Charles Edison Heads Splitdorf Companies

Charles Edison, son of the famous inventor, Thomas A. Edison, and one of the younger outstanding figures in the industrial life of the country, is the new president of the Splitdorf-Bethlehem Electrical Company and the Splitdorf Electrical Company.

The Splitdorf Electrical Company, well known as manufacturers of magnetos, spark plugs and other ignition devices, has for several months been making parts for the Edison Radio. The assembling of chassis for the Edison Radio has now been concentrated in the Splitdorf Radio Corporation, of

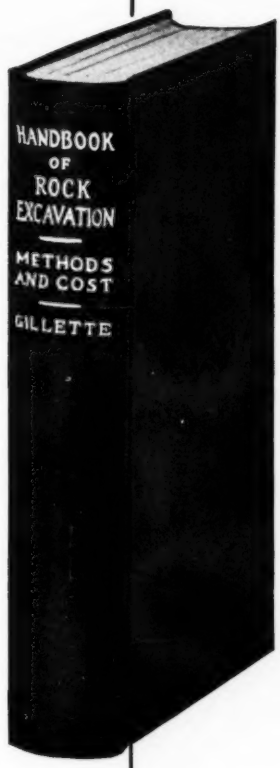
Charles Edison

which Mr. Edison is also the president, thus leaving the Splitdorf Electrical Company free to continue in its research and development in the ignition field.

Associated with Mr. Edison in the management of the Splitdorf Companies are executives who have had long, wide and varied experience in the Edison industries. Among them are: L. W. McChesney, vice-president and general manager; R. H. Allen, vice-president in charge of finance; H. F. Miller, treasurer; Howard H. Eckert, secretary, and Henry Lanahan, general counsel. Other announcements as a result of the reorganization of the affairs of the companies are L. S. Dunham, chief engineer; H. E. Krause, works engineer, both located at Newark, N. J.; and W. L. Kaiser as central district manager, with headquarters at Chicago.

J. L. Hart Machinery Company formerly known as the Coulter-Hart Equipment Company of Tampa, Fla. will represent George Haiss Mfg. Co., Inc., of New York, in the northern and eastern part of Florida.

WHO PAYS for Over-Breakage ?



Ever find yourself losing on the removal of rock slips or falls not included within the definite "neat lines" specified and shown in the blue prints? H. P. Gillette's "Handbook of Rock Excavation" (on page 15) points out this pitfall in which many a contractor has dropped a good share of his profits. You are told how to guard against it.

This is only one helpful point of the thousands contained in the Handbook. Much more valuable are those that go beyond the prevention of loss and show new ways to increase profits. All in all, there is a wealth of useful information that belongs at the elbow of the man who has a rock job on hand or ahead of him.

Our offer gives you the opportunity to examine every detail of this standard book for ten days. Read the coupon, fill in and mail.

Gillette Publishing Co., Chicago, Ill.

H. P. Gillette's "Handbook of ROCK EXCAVATION"

Borrow This Book

Send the Coupon

Here are the Subjects Exhaustively Covered in the following Chapters:

Preliminary Drainage Surveys, Design of the Drains, Drill Bits, Shape, Sharpening and Tempering, Machine Drills and Their Use, Cost of Machine Drilling, Steam, Compressed Air and Other Power Plants, Cable Drills, Well Drills, Augers and Cost Data, Core Drills, Explosives, Charging and Firing, Methods of Blasting, Loading and Transporting Rock, Quarrying Dimension Stone, Open Cut Excavation in Quarries, Pits and Mines, Railroad Rock Excavation and Boulder Blasting, Canal Excavation, Trench Work, Subaqueous Rock Excavation.

Gillette Publishing Company
221 E. 20th St., Chicago, Ill.

Please send me postpaid for free examination the "Handbook of Rock Excavation." In 10 days I agree to return the book or remit $6 in full payment and keep the book for my further profitable use.

Name.....

Company.....

Address.....

City and State..... WW-4-29

Akers of McWane Co. Joins Cox Agency

Mr. Arthur K. Akers of Birmingham, Ala., is rapidly becoming known as a writer of fiction, but as a writer of autobiography we were able to secure but little from him. Mr. Akers has so many friends in the water works field we take pleasure in presenting his picture and in giving the reason for his recent change in business connections.

As publicity manager for the McWane Cast Iron Pipe Company, Arthur K. Akers entered the advertising field in 1922. This business grew rapidly until in 1929 it ranks with the larger producers of cast iron pipe in America.

Arthur K. Akers

It has new foundries in Birmingham and Provo, Utah, the latter operating as the Pacific States Cast Iron Pipe Company, and serving the eleven western states. The McWane companies have always been liberal users of trade journal space.

In 1925 Mr. Akers began contributing short stories to the magazines, principally to RED BOOK. His stories of negro life in Alabama have since become one of the features of that magazine, one of them appearing practically every month over the past two years.

Other magazines have since begun requesting material from him to the point where the double load of full-time advertising work and a heavy fiction output has become such a burden that Mr. Akers has been forced to make a change in his arrangements.

Under the new plan, he will devote himself more largely to fiction writing, but has associated himself with the Cox Advertising Agency, of Birmingham, where he will continue to create and place the McWane Cast Iron Pipe Company and Pacific States Cast Iron Pipe Company publicity, as well as have oversight of that agency's other new industrial accounts.

Mr. Akers expresses the hope that he may continue his attendance at the water works and gas association annual conventions where he has been a familiar figure in connection with the exhibits of the McWane companies for the past seven years.

We are very happy that Mr. Akers' services are still to be available in the field of industrial advertising, and feel sure that the circulation of RED BOOK will show a marked increase in readers from the water works field.

Chain Belt Appoints New Advertising Manager Trade Publications

Mr. R. A. Shilbauer, who joined the Chain Belt Company of Milwaukee in 1920 as a rate-setter (and worked in that capacity in the various departments of the company's Grey Iron Foundry and Chain assembly plants on Park street and later became assistant advertising manager, has now been made advertising manager. He has been connected with the advertising department since 1925.

The Chain Belt Company manufactures engineering and conveying equipment, chain, transmission, concrete mixers and pavers, which are recognized under the trade name "Rex." The company also operates a plant in Cleveland, Ohio, under the name of the Stearns Conveyor Company, where belt conveyors and bulk material storage systems are made. The Chain Belt Company is a part of an affiliated group of companies consisting of the Sivyer Steel Casting Company, Federal Malleable Company and Interstate Drop Forge Company, all of Milwaukee.

Distributor Notes from Barber-Greene

An office has been opened at 527-528 Merchants National Bank Bldg., Cedar Rapids, Ia., by the Barber-Greene Company of Aurora, Ill., manufacturers of ditchers, loaders, conveyors, coal equipment, etc. Mr. Jack Marson of the Barber-Greene Company will have supervision of this office. Mr. Marson has been with the Barber-Greene Company for a number of years.

Another branch office under the supervision of Mr. Marson has been opened at 1106 Nicholas St., Omaha, Neb. Mr. W. E. Toole is in direct charge of this office.

W. S. Dickey Clay Mfg. Co. has consolidated the Atlanta and Birmingham offices, and mail should hereafter be addressed to P. O. Box 1592, Birmingham, Ala.

Whitcomb-Baldwin Combine Forces

The George D. Whitcomb Company, an organization engaged for the past fifty years in developing a complete line of gasoline, oil and alcohol burning locomotives for railway, industrial and contracting activities, and the Baldwin Locomotive Works of Philadelphia, known as one of the largest steam locomotive builders in the world, have combined forces to the extent that a substantial interest in the Whitcomb Company has been purchased by the Baldwin Company.

There is an ever increasing demand for internal combustion engines for the larger locomotives. The George D. Whitcomb Company is now building straight gear driven machines powered by gasoline, distillate and oil in sizes up to fifty tons, developing draw bar pulls in low gear, up to 25,000 lb. They have developed gas and oil electric locomotives up to 100-ton sizes and can furnish railway locomotives with a maximum draw bar pull of 50,000 lb.

The Baldwin Company will handle the products of the Whitcomb Company through its foreign representatives in all parts of the world, and through its domestic offices will handle the railway field in the United States.

The combination of the two corporations places them in a position to build every size of steam, gasoline, alcohol, distillate, Diesel, gas-electric or Diesel electric locomotive. The works of the Geo D. Whitcomb Company are located at Rochelle, Ill.

1929 Ushers in New Engines and New Plant of Waukesha Motors

The new engines and power units developed during 1929 by the Waukesha Motor Company, Waukesha, Wis., will receive adequate service by reason of the new buildings now placed in operation for the benefit of users of the Waukesha products.

Quoting from a statement of the president of the company, Mr. H. L. Horning: "New plant extensions increase our floor area 100 per cent and give additional production facilities for both our new engines and those which we have been building for some years past. Proving laboratories for both research and production engines are now starting operation. * * * Greater stocks and prompter shipments are assured by our new buildings."

Sales offices and representatives for the Waukesha Company are located in New York, San Francisco, Tulsa, Oklahoma and Houston, Texas.

Vitrified clay sewer pipe has no upkeep because it stays down

CLAY PRODUCTS ASSOCIATION
CONWAY BUILDING
Chicago

VITRIFIED Salt Glazed CLAY
Sanitary Sewer Pipe

MN&WW 4-Gray

Sullivan Spader Wins in "Blindfold Test"

Hoag and Rollins were tunneling in hard clay at Toledo. They knew air clay diggers could beat hand labor. They didn't know which diggers were speediest.

So they tried a "blindfold test." Four men in the heading got four different clay spades. Clay spattered over the names. The men exchanged tools. When the shift came out of the hole—the superintendent asked which spade they wanted.

All voted for the same tool. The superintendent scraped off the clay and recorded the name, "SULLIVAN." After one week of testing, the contractors standardized on Sullivan Spaders.

Sullivan Spaders are hard on clay, but easy on men. They are balanced, smooth-running, and powerful. They will save you money.

Send for Catalog 6081-N.

Sullivan Air Equipment for the Water Works Department

Equipment for the Water Works Department includes Sullivan Portable Air Compressors, Rock Drills, Concrete Breakers, Clay Spaders, and Portable Hoists—in addition to Air Lift Pumping Systems. *Catalog on request.*

SULLIVAN
MACHINERY COMPANY
130 S. Michigan Ave.
After May 1st, 418 N. Michigan Ave.
CHICAGO

© Sullivan Mchry. Co.

SULLIVAN TRADE MARK

Municipal Officials
Contractors
Engineers

Valuable Information Yours for the Asking

Write Now

Catalog Service

Useful Equipment Information

Watch these trade announcements for new and improved equipment

By writing the manufacturers named and mentioning this magazine, copies of the following catalogs will be sent to you without obligation

TRADE PUBLICATIONS

Pull-Shovel.—Koehring Company, Milwaukee, Wis., has just issued a very attractive broadside descriptive of the Koehring Pull-Shovel. The pull-shovel boom, instead of being hinged to the turntable casting, is hinged to a separate casting which forms the base of the jib frame. It is built in two sizes and three models; ⅞ and 1¼ cu. yd. dippers, line-of-plate struck measure. In actual operation, heap loads of 1⅛ and 1⅝ cu. yd. can be handled. Many outstanding desirable features are pointed out in this bulletin, which also gives working dimensions and specifications. Write to the manufacturer for a copy, using the name of our publication.

Gunite.—Write to the Cement Gun Construction Company, 537 S. Dearborn St., Chicago, for full information concerning this product. They will be pleased to furnish particulars and make contractors' estimates if desired.

Sani-Dri.—For all types of municipal buildings, schools and recreational centers having swimming pools, the Chicago Hardware Foundry Co. (Electrical Division), North Chicago, Ill., will be pleased to furnish complete information concerning the installation of Sani-Dri the modern, sanitary method of hair drying to prevent illness and relieve congestion in the shower rooms. Kindly give the name of our publication if writing for information.

Fiber for Sweepers.—The Huntsville Fiber & Veneer Works, Huntsville, Ala., will be pleased to send you a copy of their attractive booklet "The Story of Huntsville Hickory." This booklet gives the complete history of the growing of hickory and manufacturing process of turning it into the "Faultless Hickory Fibers" for long-life street sweepers. It contains much interesting information concerning fiber equipment, as well as about the service this company is able to render. If writing manufacturer, kindly give the name of our magazine.

Air Pump.—The Indiana Air Pump Company, Indianapolis, Ind., will be pleased to send you information concerning the air lift method of pumping wells. The catalog issued by this company stresses the dependability of this method with low depreciation and repairs. They will be pleased to send you catalog or to make quotations if you send them data and water requirements.

Paving Survey & General Highway Conditions.—To obtain an up-to-date picture of the present status of the highway business, the National Paving Brick Manufacturers Association appointed a committee of engineers to investigate the general economic status of the urban and rural highway conditions of the country. The result of this investigation is now presented as a report and may be secured by writing the association, 1245 National Press Bldg., Washington, D. C. William H. Connell was chairman of the engineering commission conducting the investigation. The report is well indexed and lists a wide range of topics such as: Highway expenditures; Highway cash dividends; Administration of the highway business; Planning highway systems; Signals; Trend in construction; Traffic and maintenance data; and an exhaustive study of the value of vitrified brick pavements. An informative and interesting book. If writing National Paving Brick Manufacturers Association for copy, kindly give the name of our publication. Ask for "Report of Investigations of Paving and General Highway Conditions."

Cement Lined Pipe.—The American Cast Iron Pipe Co., Birmingham, Ala., issued a book called "Cement-lined Cast Iron Pipe," describing the method of placing thin lining of cement in standard cast iron pipe to prevent tuberculation and reduce friction loss. If requesting copy of this book, please mention our magazine.

Centrifugal Pumps.—For a complete catalog on this equipment write to the DeLaval Steam Turbine Co., Trenton, N. J., asking for Catalog B. This is a very handsome 72-page catalog, discussing single stage and multistage pumps, for general water service, power plant service, including boiler feeding, condenser circulating and hot-well service, water works service, including main pumping units and booster, filtration and flushing service. Pumps for sewage, drainage and irrigation, elevator and hydraulic pressure, marine or fire service, oil, pulp, acid, etc. The catalog is beautifully illustrated and gives cross sectional drawings showing details of pumps. There is a section on manufacturing methods and materials, and one on testing, also just what information should be furnished in seeking plant for individual requirements. Manufacturer will be pleased to send you a copy of this informative book. Kindly mention our magazine.

Forged Steel Gate Valves.—A very handsomely bound book is catalog No. 10, issued by the Darling Valve & Mfg. Co., Williamsport, Pa., containing 32 pages filled with illustrations and giving prices and specifications of this product. Each valve is given a rigid test before leaving the factory and is subjected to hydraulic pressure equal to its rated tested pressure. If valves of standard dimensions and design cannot be used, company will be pleased to be consulted concerning deviations. If writing manufacturer, give the name of our publication, please.

Cast Iron Pipe.—For complete information on McWane Cast Iron Pipe, "what it is," "what it does," fields it serves, types, specifications, quality, special features, etc., are all told in a 54-page booklet issued by the McWane Cast Iron Pipe Co., Birmingham, Ala. The territory west of the Rocky Mountains is served by the plant at Provo, Utah, called the Pacific States Cast Iron Pipe Co., of which Mr. J. P. McWane is president. Write to the manufacturer for a copy of this booklet on McWane precalked joint cast iron pipe and fittings. Kindly mention the name of our paper.

Rawhide Packing.—Mabbs Hydraulic Packing Company, 431 S. Dearborn St., Chicago, will be pleased to send you information concerning sizes, weights and uses of their rawhide packing. This packing is practically anti-frictional, will not cut or score metal surfaces and never becomes hard or glazed. It works equally well on centrifugal or reciprocating pumps. This packing has been found of service for the marine business, in cotton gins, for mining purposes and in oil fields on pumps and wells. It is put up in standard tin pails of from 5 to 50 lb. and in kegs and barrels of 100 and 200 lb. This company makes a specialty of rawhide washers for packing the stems of water meters. They can be ordered by meter companies in 100,000 lots. Write the manufacturer for further information, kindly mentioning our magazine.

Fire Pumps.—Bulletin No. 104 has just been issued by the Chicago Pump Co., 2300 Wolfram St., Chicago, fully illustrating and describing their electric centifugal fire pumps. Booklet contains blue print drawings and a list of installations. If writing manufacturer for copy kindly mention our magazine.

Cast Iron Soil Pipe.—A very interesting booklet, containing twelve pages of beautiful modern buildings, has been

WATER WORKS

Detroit, Mich.
1,500,000 gallons

Elevated Tanks *for* Municipal Water Works

Pittsburgh-Des Moines steel tanks are especially designed for municipal water works, and have furnished water storage to many communities for over thirty years.

An elevated water storage tank takes care of the water consumption during the peak hours and insures a constant pressure at all times. It eliminates fire hazards when repairs are being made at the pumping plant.

We build complete water works system, including pipe lines, reservoirs and filtration and purification plants.

Ask for our Municipal Catalog No. 2

Pittsburgh-Des Moines Steel Company

4 Neville Island, Pittsburgh, Pa.

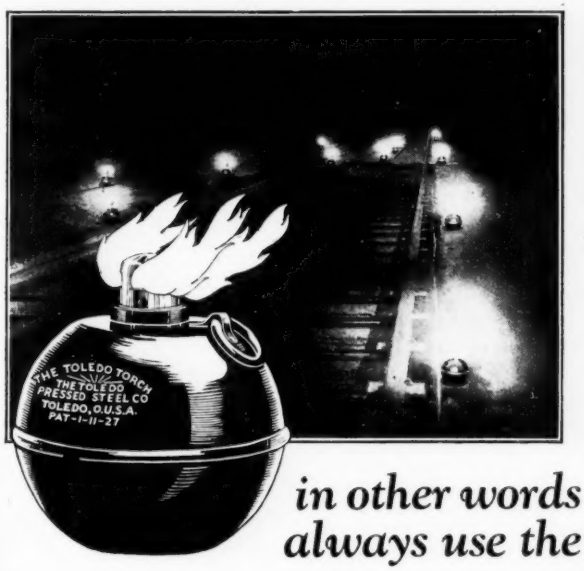
Des Moines — New York — Chicago
Atlanta — Dallas — Seattle — San Francisco

PITTSBURGH DES MOINES

Protect yourself!

with simple and direct LIGHT

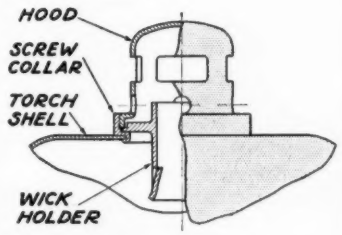
from a dependable source



in other words always use the

TOLEDO TORCH

PRETTY colored lanterns may get you by with cautious drivers, if you hire a watchman to keep them on the job. But it's the reckless ones who cause all the accidents. With them the use of uncertain signals, such as red lanterns, is a needless risk for you to take, especially when it is so much more costly than using TOLEDO TORCHES.



The New TOLEDO TORCH is dependable in all kinds of weather, is very economical in the use of fuel, and is never molested by petty thieves. The secret of its great success lies in the new ECONOMY BURNER. (Patents Pending)

IT is the only burner that will give you satisfactory service at all times. Observe carefully its construction, and *insist on having the genuine.* Similar looking imitations do not compare in performance.

Ask for the *'Champion'*

"the harder it blows the better it burns"

Made only by

THE TOLEDO PRESSED STEEL CO.
TOLEDO, O.

issued by The Soil Pipe Association, Birmingham, Ala. The booklet is an announcement of the willingness of this association to guarantee cast iron soil pipe for 100 years, or for the life of any building in which it is used. If writing the association for information concerning this proposition, kindly use the name of our publication.

"Water Services that Serve" is the title of a brochure just issued by the Copper and Brass Research Association for distribution to municipal authorities, engineers and contractors. The booklet gives general data on copper and brass tubing and pipe with special reference to copper for use in service pipe between water mains and house lines. Tensile strength, bursting pressure tests, sizes, lengths and general data about installation are included in tables and explanatory paragraphs. If writing the assocation for a copy of this booklet, kindly mention our magazine.

Boyer Riveting Hammers.—A very attractive bulletin, SP-1694, has just been received from the Chicago Pneumatic Tool Co., 6 E. 44th St., New York, covering in a very thorough manner this equipment. The booklet contains the announcement that after Feb. 1, 1929, all Boyer riveting hammers will be furnished with an improved hardened and ground valve unit, unless specifically ordered with the soft valve block. Write for a copy of the bulletin, kindly mentioning our magazine.

Pump Control.—Bulletin No. 140 has been issued by the Chicago Pump Co., 2300 Wolfram St., Chicago, listing complete pump control units for operating pumping plant. Control panels, control boards, float switches, automatic alternators, etc., are illustrated and described in this 12-page, loose leaf style bulletin. This will be an aid in selecting the proper pump control. . Manufacturer will be pleased to send you a copy, kindly give the name of our publication, if writing for copy.

Water Softeners and Purifiers.—The Graver Corporation, East Chicago, Ind., has issued a little booklet illustrating and describing the various types of water softeners and filters, as well as steel storage tanks. Hot process, cold process, zeolite and lime-zeolite treatment, for industrial plants, ice plants and railroads, as well as the smaller types for household purposes are described. More complete bulletins devoted to any special type are specified by letter. Filters for industrial and municipal works and swimming pools also receive attention. If requesting a copy of this booklet, kindly give the name of our magazine.

Dipper Trip.—A folder from the Morin Mfg. Co., 896 Main St., Holyoke, Mass., manufacturers of appliances and improvements, gives illustrations and detailed information about their Universal-Semi-Automatic Dipper Trip. This dipper trip may be adapted to any make or type of shovel, steam or air, gasoline, diesel, electric, or gas-electric and gas plus air. The outstanding features of this appliance set forth in circular are ease of operation and elimination of lost motion. Write for folder describing this equipment and also the friction-type dipper trip and tag line winder for gasoline, diesel and electric, and gas-electric and gas plus air shovels. If writing manufacturer kindly mention our magazine.

Paved Invert Culverts.—"Paving the Culvert to Combat Erosion" is the title of a comprehensive pamphlet issued by the Armco Culvert Mfrs. Association, Middletown, O. This product is designed for use where culverts carry highly sedimentary streams, on steep grades, in mountainous country, storm sewers, etc. The booklet illustrates in detail the paved invert and described tests applied in developing it. The culvert must be made to withstand hydraulic traffic within and vehicular traffic from above. The booklet described the Armco system. Kindly give the name of our publication if writing manufacturer for literature.

For Water Works Campaigns.—Of interest to city officials and water works engineers in promoting campaigns for securing water works or renewals is the booklet issued by the Cast Iron Pipe Publicity Bureau of the Cast Iron Pipe Research Association, 122 S. Michigan Ave., Chicago. It is called Community Advertising, and shows colored reproductions of posters, street banners, direct mail literature and newspaper advertising to be used in securing this type of improvements for the home town. This campaign material will be furnished free by the association to aid in the cause of water works. Write for a copy of Community Advertising and find out just how much free help is available in aiding you with your problems. Kindly mention the name of our publication when writing.

Automatic Valves.—Catalog No. 24 has been issued by the Golden-Anderson Valve Specialty Co., Pittsburgh, Pa., to present with illustrations and descriptions their well known automatic cushioned valves for steam and water service and to call attention to many new styles of valves. The catalog contains 200 pages, well printed on enamel paper, with a complete index. A very useful and attractive catalog on valves. The Pittsburgh address of the Golden-Anderson Specialty Co. is Fulton Building. Kindly mention our magazine, if writing.

Gasoline Hoists.—The American Hoist & Derrick Co., St. Paul, Minn., has just issued an eight-page folder concerning the "American" silent chain drive gasoline hoists for general hoisting work. The booklet gives specifications, outstanding features and construction details. The engine and hoisting drums are mounted on a cast iron frame insuring absolute alignment of all working parts. The unit is entirely self-contained.

Monarch Tractors.—Wise planning highway officials, who were snowed under during the past winter, will look to the snow removal machinery in time to have it on hand next year when the first snow flies. The Allis-Chalmers Mfg. Co., Milwaukee, Wis., will be pleased to send you literature concerning the outstanding features of the Monarch "75" with V-type plow for keeping the roads clear in the heaviest snows.

Expansion Joints.—Write to the Philip Carey Co., Lockland, Cincinnati, O., for full particulars concerning their Elastite Expansion Joint, which requires only ordinary tools and workmen for installation. If writing manufacturer for literature concerning this product, kindly mention our publication.

Snow Removal, 1929.—This is the title of a very attractive booklet which the Caterpillar Tractor Co., San Leandro, Calif., has issued looking forward to the work and equipment which will be needed for next winter to keep the roads clear. Removal in Cities; Cost of Removal; America's Snowbelt and Loss to Business are some of the topics treated. Equipment for meeting these problems is illustrated and described. Send for a copy of this booklet and plan to meet this situation before it becomes a problem. Kindly mention our magazine, if writing manufacturer.

Well Systems.—Write to Layne & Bowler, Inc., Memphis, Tenn., or any of their representatives located in all the principal cities, for information about the Layne Water Well Systems. They will be pleased to give you the benefit of their long years of experience in this field.

Leadite.—A self-caulking material for cast iron pipe manufactured by the Leadite Co., Land Title Bldg., Philadelphia, Pa. The manufacturer will be pleased to send you detailed information and records of pipe lines where this product was used. If writing, kindly give the name of our paper.

Sludge Removal.—The Link-Belt sludge collector is recommended by the manufacturer for its sturdy mechanism and reliability in removing sludge from sedimentation tank. An excess of accumulation of sludge will not slow down or stop operation. For complete information concerning this or other sewage treatment plant equipment, write to the Link-Belt Co., 300 W. Pershing Road, Chicago. Kindly mention our magazine.

Stops and Water Works Products.—For information on the full line of stops and other products for water works, write to the Mueller Co., Decatur, Ill., for catalog. They will be pleased to furnish information about water works companies using their curb stops and corporation stops for standard equipment.

GOLDEN-ANDERSON

Automatic "Cushioned" Controlling Altitude Valves

GOLDEN-ANDERSON
Patent Automatic Cushioned Controlling Float Valves

Adapted to automatically maintain a uniform water level in feed-water heaters, tanks, reservoirs, and pans. Very sensitive.

Operating on ½-in. to ¾-in. variation. No exhaust or expensive water waste. Can be furnished for hot or cold initial water supply. Reliable and dependable under varying pressure.

Sizes ½ in. to 24 in.

Cushion All Water Surges

Automatically maintain a constant stage of water in reservoirs, tanks and standpipes.

They do away with the annoyances of Freezing Valves and Float fixtures inside of the Tanks or Floats and Fixtures outside of Tanks. "Three Ways of Closing These Valves."

1st—Automatically, by water.
2nd—By electricity, if desired.
3rd—By Hand.

May also be arranged to automatically close when a break occurs in the mains. When necessary they may be so connected as to "work both ways" on a single line of pipe.

The double cushion effect of air and water eliminates water hammer.

There are no dangerous surges to burst water mains. **Write for details.**

REMEMBER
Valves cushioned at all times by air and water. No water hammer or bursting mains.

"Made with stop starter attachment for centrifugal pumps."

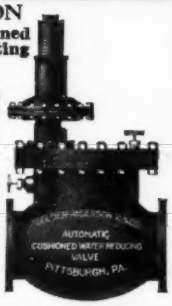
Golden-Anderson Valve Specialty Co.
1385 Fulton Bldg., Pittsburgh, Pa

GOLDEN-ANDERSON
Patent Cushioned Water Relief Valves

1. Automatically relieve excess pressure.
2. Prevent stress, strain and bursting of mains.
3. Correct mechanical construction.
4. Perfect air and water cushioning.
5. No metal-to-metal seats. No hammering or shocks.
6. Angle and globe pattern. Sizes 3 to 24-in.

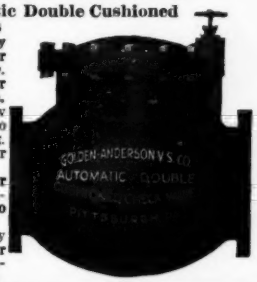
GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Pressure Regulating Valves

1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly Cushioned by water and air. No metal-to-metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operates quickly or slowly as required—No attention necessary.
5. Positively no hammering or sticking. Sizes to 24 in.



GOLDEN-ANDERSON
Pat. Automatic Double Cushioned Check Valves

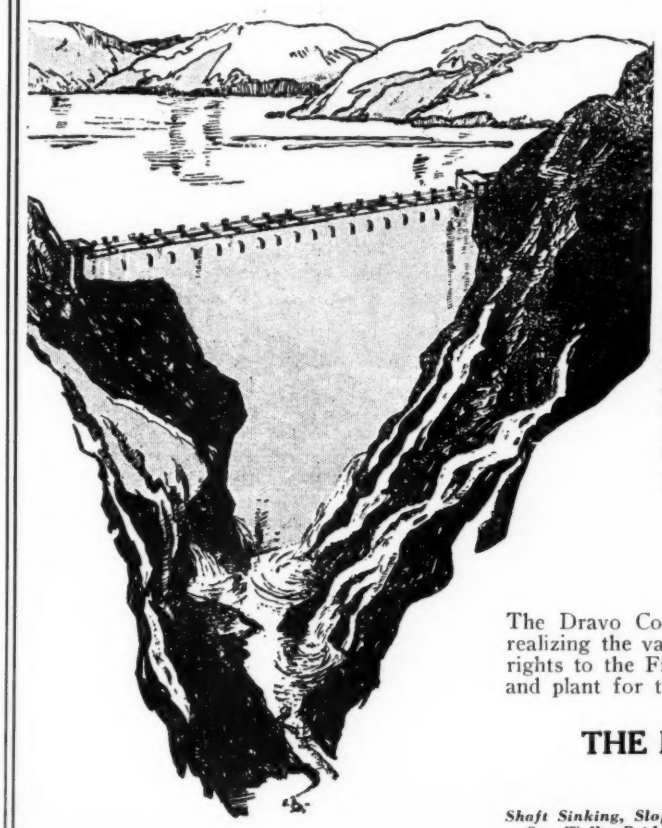
1. Especially adapted for Water-Service.
2. For High or Low Pressure.
3. Thoroughly Cushioned. No Chattering, Hammering, or Sticking.
4. Globe or Angle Patterns up to 24 in.
5. Especially adapted for hydraulic elevator service.



GOLDEN-ANDERSON
Pat. Automatic Cushioned Water Float Valves

1. Automatically Maintain Uniform Water Levels in Tanks, Standpipe, etc.
2. Instantly Adjusted to Operate Quickly or Slowly.
3. Floats Swivel to any Angle—Most Satisfactory Float Valves known.
4. No Metal - to-Metal Seats—No Water Hammer or Shock.
5. Cushioned by Air and Water.

Sizes ¼" to 24".



Have You a Leakage Problem?

Francois Cementation Process

The surest and most economical method of overcoming difficulties due to the presence of water or bad ground.

The cementation process—the specialized high pressure injection of liquid cement mixtures into cavities, fissures, or cracks—has been developed to a high degree in Europe, and more particularly in Great Britain by the Francois Cementation Company, who have a long list of successful contracts to their credit, including internationally known structures.

Some features of the Francois Process are:

Grout is under perfect control;
Pressures to 3,000 pounds per square inch if required;
Chemical processes for a hundred and one different cases;
Wide experience in many years specialization.

The Dravo Contracting Company, after many years successful work and realizing the value of specialized grouting, have acquired the sole American rights to the Francois patents, and at their disposal is a highly skilled staff and plant for the execution of contracts.

THE DRAVO CONTRACTING COMPANY
PITTSBURGH, PA.

Shaft Sinking, Slopes, Tunnels, Pneumatic Caissons, Submarine Construction, Locks, Dams, Sea Walls, Bridge Piers, Steel Barges, Steel Towboats, Inland Waterway, Floating and Terminal Equipment, Steel Headframes, Steel and Concrete Tipples.

Meter Repair.—For repairing or testing any make or size of water meter, write to the Reading Meter Repair Co., Inc., Reading, Pa., for prices and particulars. They will be pleased to furnish information concerning any hydraulic supplies and equipment.

Deep Well Power Pump.—The United Iron Works, Inc., Springfield or Kansas City, Mo., will send upon request literature of interest on the "Pomona" double stroke deep well power pump. Booklet contains much interesting information on deep well pumping and pumping problems. If writing for literature, kindly mention our magazine.

Sanitary Specialties.—For information on a complete line of special sanitary products manufactured by the Servicised Products Corp., address the company at 6051 W. 65th St., Chicago. Among these products are bituminous rope, sewer compound, sewer belts, asphalt liner slabs, etc.

Road Oil.—Standard Road Oil is offered by the Standard Oil Co. of Indiana, 910 S. Michigan Ave., Chicago, for obtaining dustless dirt or gravel roads and giving a waterproof roadway. Write to the company for information on application.

Hydrants, Valves, Etc.—Write to the Columbian Iron Works, Chattanooga, Tenn., for descriptive literature of the Columbian Fire hydrants, Gate valves, Valve boxes, Hydrant extension sections, or other water works equipment. We would appreciate it if you would mention our publication if asking for information.

Cast Iron Pipe.—United States Cast Iron Pipe & Foundry Co., Burlington, N. J., will be pleased to send you literature explaining the differences between the deLavaud Cast Iron Pipe and other types of pipe. This is a centrifugally cast pipe in which the graphite particles are finely divided and evenly spread.

Pipe Cutting Tool.—A folder from the Tucker Company, Inc., 75 Murray Street, New York City, gives a detailed description and price list of parts in all sizes of their cutter for cast iron pipe. This tool can be used in any ordinary trench without extra excavating. It will cut a piece one inch long or more at any point without starting joints or otherwise disturbing the main, and will make a clean cut in a gas or water main in the trench. Write to the Tucker Company for literature and price list of the Anderson Pipe Cutting Tool. In writing, kindly give the name of our magazine.

Wrought Iron Pipe.—"The Installation Cost of Pipe" is the title of a Bulletin issued by the A. M. Byers Company, Pittsburgh, Pa., containing cost data and full particulars concerning this product and its uses. Ask for Bulletin No. 38, giving the name of our magazine.

Compressors.—The Sullivan Machinery Company, 122 S. Michigan Ave., Chicago, Ill., has issued a new handbook on Compressed Air Practice, containing numerous suggested uses for compressed air as an aid to speeding production and improving products. It also contains helpful information concerning piping, lubrication and the care of compressed air equipment. The manufacturer will be pleased to send a copy of this book upon request, and we would appreciate it if you would mention our publication if writing.

Automatic Control Valves.—The Ross Valve Mfg. Co., Inc., Archibald St., Troy, N. Y., will be pleased to furnish you with particulars regarding their automatic pressure control valves for feed water filters, portable fire hydrants, hydraulic engines, hydraulic booster pumps, etc. Write for information, giving the name of our publication.

Clay Pipe.—The Clay Products Association, Conway Building, Chicago, makers of vitrified clay pipe, will be pleased to send you full information regarding this product.

Meters — Gauges — Valves. — Information on complete equipment for filtration plants may be secured by writing the Simplex Valve & Meter Company, 6749 Upland Street, Philadelphia, Pa. The Simplex Rate of Flow Controller is adaptable to large and small filter plants from 30-inch effuent to 3-inch. The Simplex Venture Type Meter indicates, records and totalizes the rate of flow, and the Simplex Filter Gauges may be had in many combinations of Indicating, Recording and Totalizing. If writing for particulars on this equipment, kindly mention our nagazine.

Filtration Plants.—Norwood Engineering Company, Florence, Mass., will be pleased to send you full particulars regarding the Norwood Municipal Filtration Plants. Kindly give the name of our publication if requesting information.

Compressors, Drill Sharpeners, Pneumatic Tools.—The Sullivan Machinery Company, 122 South Michigan Avenue, Chicago, Ill., will be pleased to send you a copy of their new eight-page folder, Form 2007, calling special attention to their portable air compressors, mounted to suit your requirements; drills, spaders, hoists and sharpener—all illustrated and described. Catalogs will also be sent upon request, write for information. Kindly mention our magazine, if writing manufacturer,

Meter Boxes.—The Ford Meter Box Company of Wabash, Indiana, have a special bulletin on the Ford Type S Meter Boxes for "warmer climates." Meters can be set or removed in an instant. The Ford standard testers can be adapted for testing meters in a series, each meter clamped in separately and the work economically and conveniently handled.

Water Meters.—Write to the Badger Meter Manufacturing Company, Milwaukee, Wis., for detailed bulletin on their complete line of meters, ranging in size from the smallest disc to the 12-in. turbine. This information will point out the way to reduce your pumping costs, by the use of the Badger Turbine Meter at the pumping station and the meters on the service lines. Many changes were made during the past year to increase efficiency and serviceability. If writing for literature, kindly mention our magazine.

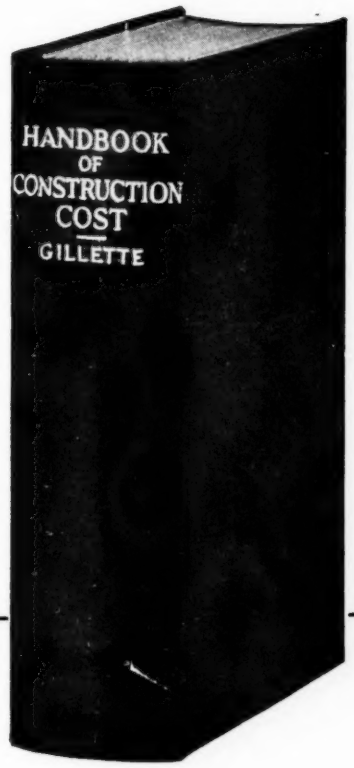
Excavator.—Write to the Bucyrus-Erie Company, South Milwaukee, Wis., or Erie, Pa., for bulletin on their D-2 Diesel Drag-Shovel. This shovel is built for the hardest work at a minimum cost. Easily convertible to clamshell-crane, shovel or dragline. Manufacturer will be pleased to furnish you with performance records of this equipment.

Dosing Tank Counter, Sewage Tees, Nozzles, Etc.—Bulletin No. 100, issued by the Pacific Flush-Tank Co., 4241 Ravenswood Ave., Chicago, contains full descriptions, table of weights and price list of this equipment. The new dosing counter for checking the amount of sewage treated by keeping count of the number of times the dosing tanks have discharged may be mounted on the roof of the tank or attached by brackets to the side wall. The counter is protected by a weather-proof cover and has been operated in all kinds of weather. For complete information about the Marley Sewage Tees for sprinkling filter beds and nozzles of the threaded spindle type, lock spindle type and spindle and half spray plug, write to the manufacturer. If requesting literature on this equipment, we would appreciate it if you would mention our magazine. The New York office of this company is at 9 Park Place.

Industrial Engines.—Bulletin No. 201 has been issued by the Weber Engine Company, Kansas City, Mo. This is a horizontal, 2-cycle, single cylinder, medium compression engine, of comparatively light weight, designed and constructed to insure the greatest strength and rigidity. For users requiring power units of 30-hp., 40-hp., 60-hp., 80-hp., 100-hp. and 125-hp. it affords a thoroughly reliable, compact and economical oil or gas engine of great simplicity. This engine is adaptable for water, sand, drainage or irrigation pumps, electric generators, air compressors, rock crushers, pipe line machinery, mills and industrial plants. The bulletin contains illustrations and cross-sectional drawings and full description. Write for a copy of this bulletin, kindly mentioning our magazine.

What's the Last Step Before

"I Give Up" ?



In your experience did a particularly tough estimating problem ever have you on the verge of giving up? Whether you did or not you realize that "I give up" usually means the other fellow gets the job.

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